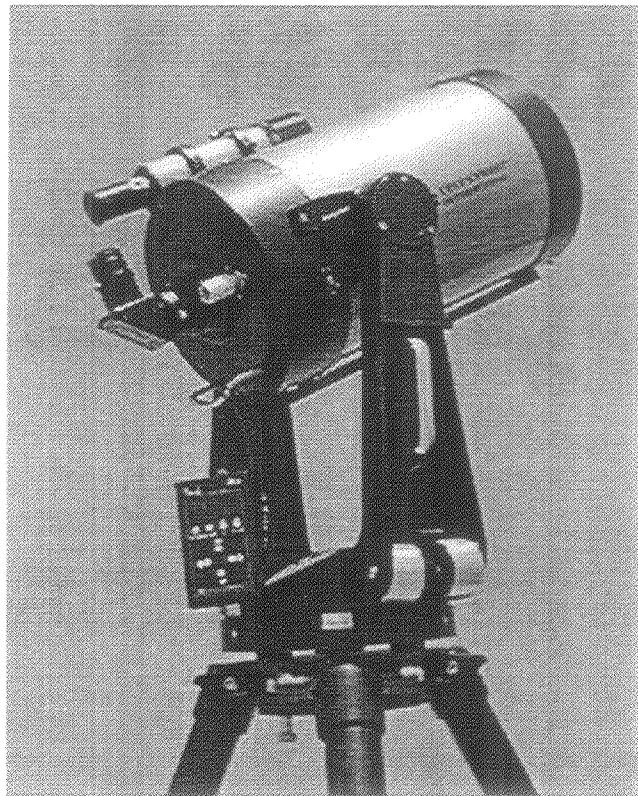


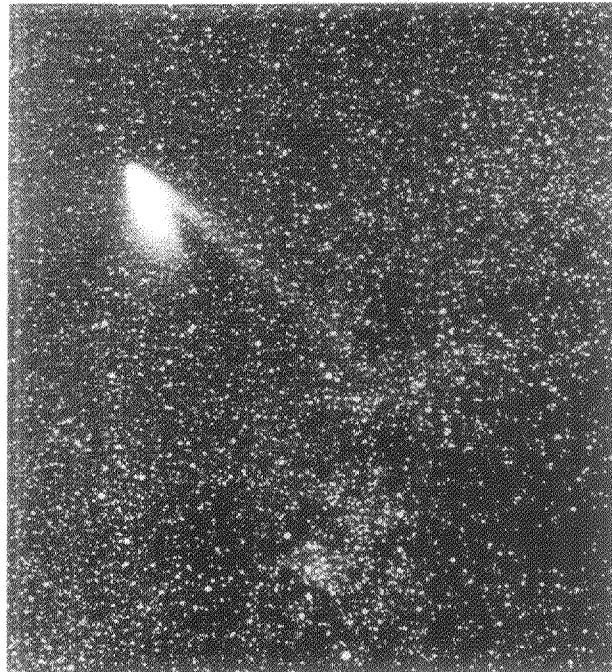
**CELESTRON®**



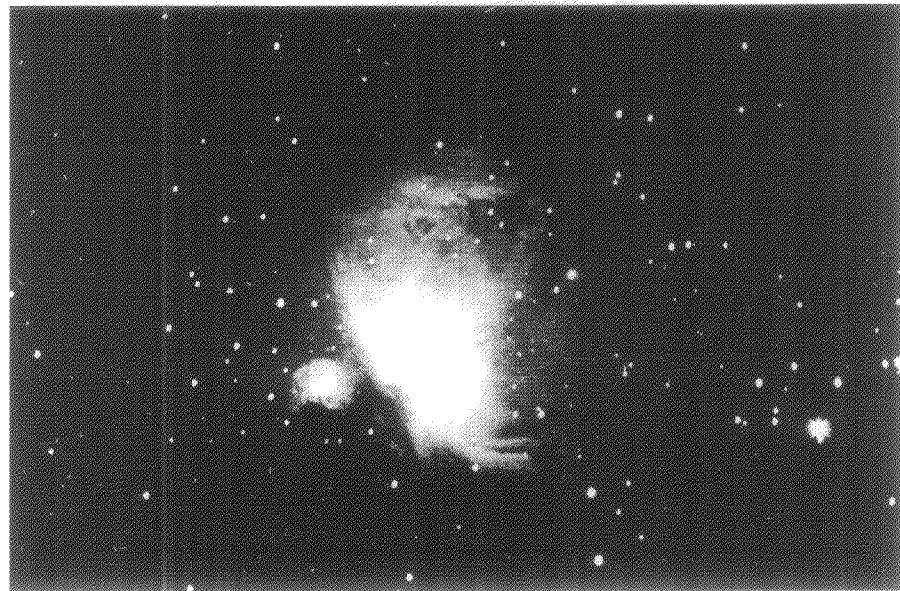
***8" ULTIMA® 2000***  
**INSTRUCTION MANUAL**

## **WARNING**

**Removal of the Optical Tube Assembly, the Fork Tines or the Drive Base will disable precise alignment calibrations and void the warranty of the telescope.**



Comet Hale-Bopp in the Milky Way (March 1997): Photo taken with a 50mm Lens mounted piggyback on the Ultima 2000.



This is an 8 minute exposure at f/6.3 on Ultima 2000, 8 inch telescope of the Orion Nebula, M42. The film used was Hypered Fuji 400. Accessories used were the optional Heavy Duty Wedge, Radial Guider, and the Microguide eyepiece.

***This manual is dedicated to the memory of Mark J. Coco.***

*Mark will be remembered by many people for his love of Astronomy and his talent for writing. He made many contributions to Celestron as our Staff Astronomer and Technical Writer for which we will be forever grateful. He will be missed as a great friend and co-worker.*

*In sadness there is peace .... Mark is where he always loved to be..... under the stars.*

---

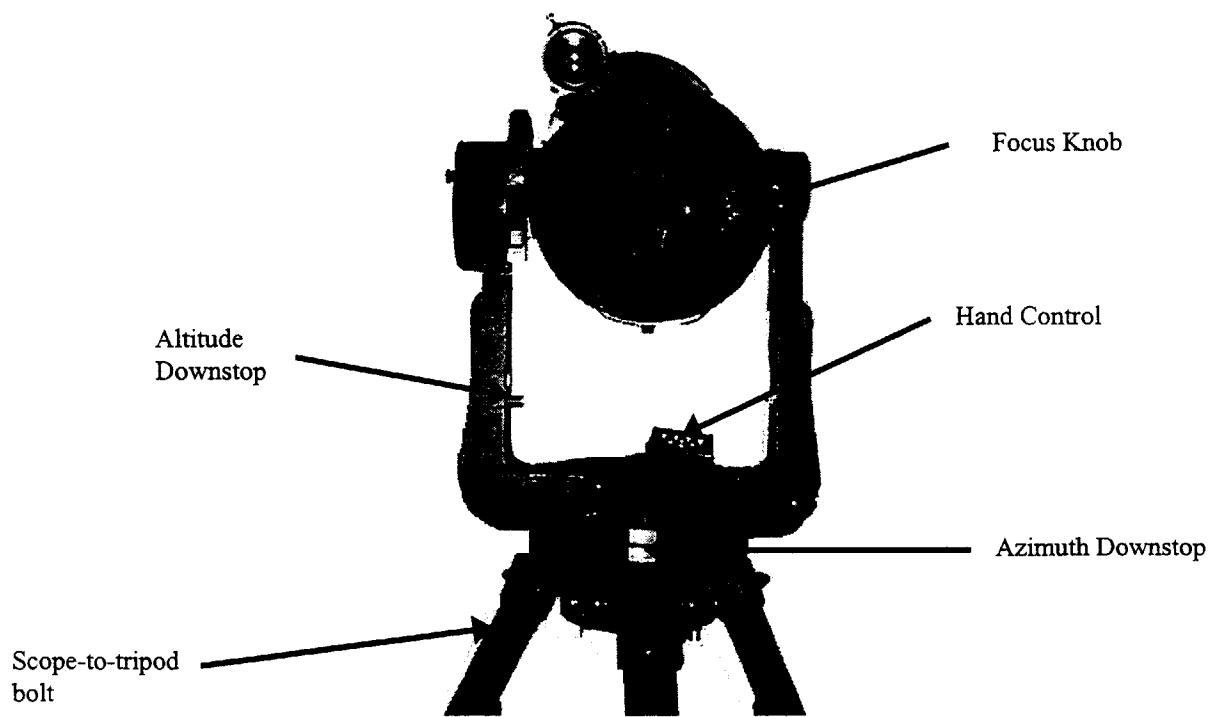
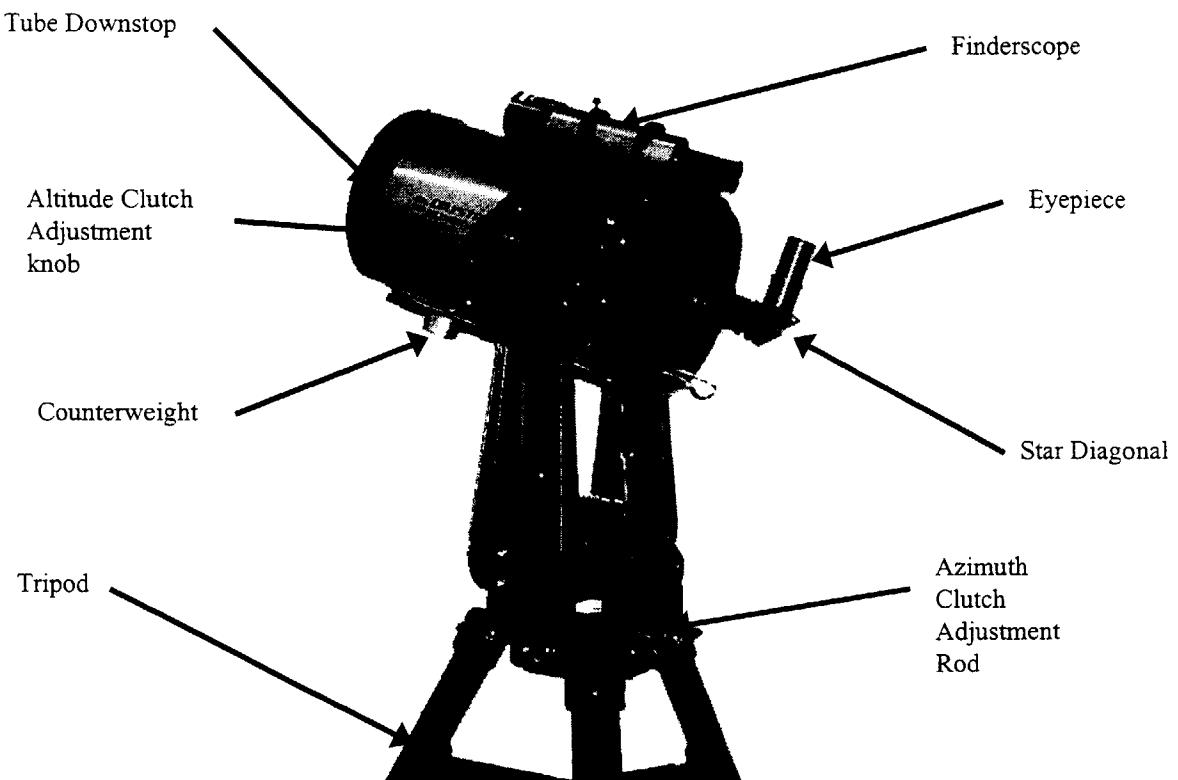
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Congratulations on your purchase of a Celestron Ultima 2000! The Ultima 2000 ushers in a whole new generation of computer automated technology. Simple and friendly to use, the Ultima 2000 is up and running after locating just two alignment stars. And then the fun begins. Start off with our built-in Sky Tour package or begin to observe any of the over 10,000 objects in the standard data base. The Ultima 2000 will unfold for you and your friends the wonders of the planets, stars and galaxies. You may even discover and track your own comet!

Many of the standard features of the Ultima 2000 have never been available previously:

- Incredible 10°/second (or faster) slewing speed;
- Fully enclosed optical encoders for position location - you can manually move the telescope and it will still know its location;
- Precision worm drive on both axes;
- Radical and innovative new fork mount;
- Extremely low power consumption - runs off 8 AA batteries for 20 hours under normal usage;
- CCD compatible, auto-guider ready;
- RS-232 port allows use of PC's; and
- Many other high performance features!

The Ultima 2000's deluxe features combine with Celestron's legendary Schmidt-Cassegrain optical system to give amateur astronomers the most sophisticated visual and photographic telescope available on the market today.

Take time to read through this manual before embarking on your journey through the universe. It may take a few observing sessions to become familiar with your Ultima 2000. The laminated summary sheet has a very useful diagram that will demonstrate access to the different menus of operation. Also, you should keep this manual handy until you have fully mastered your telescope's operation.

Your Ultima 2000 telescope is designed to give you years of fun and rewarding observations. However, there are a few things to consider before using your telescope that will ensure your safety and protect your equipment.

---

## **Warning: Be careful with solar observing**

**Never look directly at the sun with the naked eye or with a telescope (unless you have the proper solar filter). Permanent and irreversible eye damage may result.**

Never use your telescope to project an image of the sun onto any surface. Internal heat build-up can damage the telescope and any accessories attached to it.

Never use an eyepiece solar filter or a Herschel wedge. Internal heat build-up inside the telescope can cause these devices to crack or break, allowing unfiltered sunlight to pass through to the eye.

Never leave the telescope unsupervised, either when children are present or adults who may not be familiar with the correct operating procedures of your telescope.

Never point your telescope at the sun unless you have the proper solar filter. When using your telescope with the correct solar filter, always cover the finderscope. Although small in aperture, the finderscope has enough light gathering power to cause permanent and irreversible eye damage. In addition, the image projected by the finderscope is hot enough to burn skin or clothing.

This section is intended to help the new user get the Ultima 2000 up and running, in the altazimuth configuration, immediately after assembly. To assemble the telescope, refer to the chapter entitled "Assembling your Ultima 2000". There are two steps required to become familiar with the Ultima 2000's operations. First, use the telescope indoors to get acquainted with all the controls and second, use the telescope under the night sky to find objects. This section covers both.

## Getting Familiar - Indoor Use

This section will show you how to navigate through the user interface of the Ultima 2000. The interface has four buttons that allow you to run the Ultima 2000 hand control software. One is the MENU button which will bring you back to the main menu. The other three are the control buttons named ENTER, UP, and DOWN. The control buttons can act on any item that is blinking on the display screen. When you turn the telescope on, the first screen that appears is MENU ALIGN. You will notice the "A" in ALIGN is blinking. This indicates that you can use the control buttons on this item (Note : In this document, bold text represents a blinking character on the display). This section will also show you how to Slew the telescope.

### How to scroll through the Main Menu List.

Here is an example that illustrates how to scroll through the different items of the main menu. There are eight items in all. A detailed description of each item is discussed later.

| <u>ACTION</u>                         | <u>NOTES</u>                                       | <u>DISPLAY</u>  |
|---------------------------------------|--|-----------------|
| Turn on the telescope                 | The telescope always starts off at the ALIGN menu. | MENU<br>ALIGN   |
| Press the button labeled DOWN         | Scrolling to different items in the main menu.     | MENU<br>GO TO   |
| Press the button labeled DOWN         | Scrolling to different items in the main menu.     | MENU<br>CATALOG |
| Press the button labeled DOWN 4 times | Scrolling to different items in the main menu.     | MENU<br>SETUP   |
| Press the button labeled UP 6 times   | Scrolling back to the original item                | MENU<br>ALIGN   |

### **How to Enter into a Menu Item and Return to the Main Menu List**

---

The blinking letter indicates that the item can be “acted on” by any of the three control buttons (ENTER, UP, DOWN). In this section we will illustrate how to enter into a menu item and how to get back out to the main menu.

| <b><u>ACTION</u></b>                             | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b>                    |
|--|---|--|
| Turn on the telescope and scroll to MENU CATALOG |   | MENU<br>CATALOG                          |
| Press the button labeled ENTER                   | Entered into the CATALOG menu. The “S” is blinking so we can press ENTER or UP/DOWN   | NAMED<br>STAR                            |
| Press the button labeled ENTER                   | Entered into a list of named stars. Scroll UP or DOWN to find other stars.  | 0138-572<br>ACHERNAR                     |
| Press the button labeled DOWN 12 times           | Scrolled to a star named Betelgeuse.  | 0555+074<br>BETELGEU                     |
| Press the button labeled ENTER                   | A list of information on the star scrolls by and an option to go to the object appears. Wait 5 seconds and the screen returns to the previous screen. | GO TO<br>(scrolling list of information) |
| Press the button labeled MENU                    | Returned to the main menu.  | MENU<br>CATALOG                          |

---

### **How to Slew the Telescope**

This section uses the direction buttons that control the motors. These are the four buttons laid out in a diamond pattern underneath the control buttons. They will be referred to as the Diamond buttons. It is nice to see the telescope slew when getting familiar with the operation of the telescope. It turns out, that when observing, the slew function is almost never used because it is more convenient to move the telescope by hand. This is true for first time users as well as established amateurs. Here is how to slew the telescope:

| <b><u>ACTION</u></b>   | <b><u>NOTES</u></b>  | <b><u>DISPLAY</u></b>                            |
|--|--|--|
| Turn the Telescope ON<br><i>(For simplicity, if the telescope is already on, cycle power{turn off then on}.)</i> |  | MENU<br>ALIGN (if you just turned the scope on.) |
| Press the right Diamond button.  | The telescope moves at center speed in the westerly or clockwise direction.  | SPEED<br>CENTER                                  |
| While holding the right Diamond button<br>Press the UP button once   | Now the default speed is set to finder rate (2° per second)  | SPEED<br>FINDER                                  |
| Let go of the Diamond button   | The telescope stops moving and the display returns to its last Menu location.  | MENU<br>ALIGN                                    |
| Press any Diamond button   | The telescope moves at finder rate.<br><i>You will need to balance the telescope to get it to move in Altitude (Up/Down) smoothly.</i> | SPEED<br>FINDER                                  |
| Press the right Diamond button then while holding down the right button, press the left diamond button.          | The telescope moves at slew speed (>10° per second)  | SPEED<br>FINDER                                  |

To get the telescope to slew, set the SPEED to FINDER using the above procedure. Hold down the Diamond button corresponding to the direction you want the telescope to slew, then press the opposite button to reach the slew rate.

## Using the Telescope Under the Night Sky

The purpose of this section is to get the telescope aligned and tracking under the stars as soon as possible. You need to have the telescope assembled and on the tripod to utilize this quick setup section. You also need to balance the telescope. See the section Balancing the Telescope in the Chapter 3.

### *Two Star Alignment*

| ACTION  | NOTES   | DISPLAY             |
|---|---|---------------------|
| Turn the telescope ON<br>Turn the hand control ON   | The telescope always starts off at the ALIGN menu.  | MENU<br>ALIGN       |
| Press ENTER   | Entered into the ALIGN menu and the message "INITIALIZING" scrolls across followed by the prompt to set the azimuth downstop. | SET FORK<br>TO ZERO |
| Move the telescope to its downstop positions in both Alt and Az. ( <i>See the Chapter on the Hand Control, Menu Setup</i> ) | Initialized the encoder downstop position for azimuth.  | TUBE TO<br>DOWNSTOP |
| Press ENTER   |   |                     |
| Press ENTER   | Initialized the encoder downstop position for altitude.   | SKY<br>ACHERNAR     |
| Press ENTER   | Entered into the star list catalog.   | NEW OBJ<br>ACHERNAR |
| Use the UP/DOWN buttons to scroll through the list of alignment stars.<br>(example: ALTAIR - press DOWN nine times)         | Scrolled to first alignment star.   | NEW OBJ<br>ALTAIR   |
| Move and center telescope on alignment star and press ENTER   | Aligned the Ultima 2000 to first alignment star.<br><i>NOTE: Move the scope by hand and center with the diamond buttons</i>   | SKY<br>ALTAIR       |
| Press ENTER   | Entered back in star list   | NEW OBJ<br>ALTAIR   |
| Use the UP/DOWN buttons to scroll to a second alignment star.<br>(example Deneb - Press DOWN 7 times)                       | Scrolled to second alignment star.  | NEW OBJ<br>DENEBO   |
| Move and center telescope on alignment star and press ENTER   | Aligned to second star and the warp error message displays briefly. An error of less than 0.5 is desirable.                   | NEW OBJ<br>W=(<.5)  |
| A few seconds pass  | Display returns to the SKY screen after a few seconds.  | SKY<br>DENEBO       |
| Press MENU  | Returns you to the ALIGN Menu.  | MENU<br>ALIGN       |

Note: Even with the tracking motors off, the telescope still keeps track of the passage of sidereal time.

## ***Turning Tracking On***

---

To turn tracking on or off, start at the SETUP menu. The instructions below will start there. Here is how to do it:

| <b><u>ACTION</u></b>   | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b>                            |
|------------------------|---|--|
| Get to the SETUP menu. |   | MENU<br>SETUP                                    |
| Press ENTER            | Speed could be at FINDER, PHOTO, or 2 X SDRL. It defaults to the last setting used.                                       | SPEED<br>CENTER<br>(will be at the last setting) |
| Press DOWN             | Scrolls through the different setup functions.  | TRACKING<br>OFF                                  |
| Press ENTER            | Moves the cursor to "O" of OFF. This makes it possible to change the tracking state of the telescope.                     | TRACKING<br>OFF                                  |
| Press DOWN             | Set the telescope motors to track in Alt-Az rates. If the scope is on a wedge, then set tracking to EQ NORTH or EQ SOUTH. | TRACKING<br>ALT AZM                              |
| Press MENU             | Returns to main menu.   | MENU<br>SETUP                                    |

## ***Finding Objects***

---

To use this section, the telescope has to be aligned to the sky. See the previous reference section. This quick reference will show you how to find stars, Messier objects and Planets. For more information, see the Section "Menu Catalog" in Chapter 5.

| <b><u>ACTION</u></b>  | <b><u>NOTES</u></b>                            | <b><u>DISPLAY</u></b>                  |
|---|--|--|
| Go to the CATALOG Menu  |  | MENU<br>CATALOG                        |
| Press ENTER   | Enter the Named star list in the Catalog menu. | NAMED<br>STAR                          |
| Press ENTER and UP/DOWN to find a star that is up. <i>example, Arcturus</i><br><i>Press Down 11 times</i> |  | 1416+191<br>ARCTURUS<br>(example star) |
| Press ENTER, wait 1/2 second and press ENTER again.   | The telescope will slew to the object.         | 1416+191<br>ARCTURUS<br>(example star) |

### ***Find Messier Objects***

|  |   |                  |
|--|---|------------------|
| Press MENU, press ENTER, press UP four times   | Returned to the Menu Catalog, enter the Menu Catalog, and scroll through the different catalogs until the Messier catalog comes up. | M 001            |
| Choose a Messier object that is up.<br>Consult a star atlas. <i>example: M13</i><br><i>Press ENTER two times</i> | The second zero is blinking. Use the UP/DOWN arrows to change it.   | M 001            |
| Press UP   |   | M 011            |
| Press ENTER and then UP two times  |   | M 013            |
| Press ENTER, wait 1/2 second and press ENTER again.  | The telescope slews to the chosen Messier object  | GO TO<br>SLEWING |

| Find Planets  |   |                            |
|---|---|----------------------------|
| Press MENU, press ENTER, press the UP or DOWN buttons until the display reads...          | Scroll though the different CATALOGS        | SOLAR SYSTEM               |
| Press ENTER   | The last date entered shows in the display. | 02-17-97                   |
| <i>for the example date of 3-18-97</i><br>Press ENTER and press the UP Arrow once         | Change the month from Feb. to March.        | 03-17-97                   |
| Press ENTER twice and press UP once.  | Change the date.                            | 03-18-97                   |
| Press ENTER three times   |   | 2320-066<br><b>MERCURY</b> |
| Use the UP/DOWN arrows to chose the desired planet. <i>example VENUS</i><br>Press UP once | Venus is selected from the database         | 0240+178<br><b>VENUS</b>   |
| Press ENTER, wait 1/2 second and press ENTER again.                                       | The telescope slews to Venus                | GO TO SLEWING              |

The Ultima 2000 is a sophisticated computerized telescope with the GO TO function. The Ultima 2000 can be used in either Altazimuth mode or Equatorial mode (optional wedge #93655 is required). In addition, the Ultima comes standard with Starbright® coatings, an enhanced multi-layer coating on the primary and secondary mirrors for increased reflectivity. Also, the corrector plate is fully coated to allow maximum light transmission. The Ultima 2000 is shipped in three boxes. One contains the telescope, one contains the tripod and the third contains the standard accessories, which are:

- 26mm Plössl Ocular 1-1/4"
- Visual Back 1-1/4"
- Star Diagonal, Prism 1-1/4"
- 7x50mm Finderscope with Bracket
- Lens Cap
- Standard counterweights (1 sliding weight, four small weights)
- no tool bolts for attaching the telescope to the tripod
- bolts for attaching the telescope to the optional wedge
- diameter rod for azimuth clutch adjustment

The Ultima telescope should be set up indoors the first time so that it is easy to identify the various parts and familiarize yourself with the correct assembly procedure before attempting it outdoors.

Remove the tripod and telescope from their respective boxes. Remove all the accessories as well. Save the boxes since you may want to ship your telescope at some time in the future.

---

## Setting Up the Tripod

For maximum rigidity, the Celestron field tripod has a leg support bracket. This bracket fits snugly against the tripod legs, increasing stability while reducing vibration and flexure. However, the tripod is shipped with each arm of the leg support bracket in between the legs so the tripod legs can collapse. To set up the tripod:

1. Hold the tripod with the head up and the legs pointed toward the ground.
2. Pull the legs away from the central column until they will not separate any further. A small stop on the top of each tripod leg presses against the tripod head to indicate maximum separation.
3. Rotate the tension knob (located underneath the support bracket on the central column) clockwise until it is close to the bottom of the central column.
4. Turn the leg support bracket until the cups on the end of each bracket are directly underneath each leg.
5. Rotate the tension knob clockwise until the bracket is secure against the tripod legs. **Do not over tighten.**

The tripod will now stand by itself. Once the wedge and/or telescope are attached to the tripod, readjust the tension knob to ensure that the leg support bracket is snug. Once again, do not over tighten!

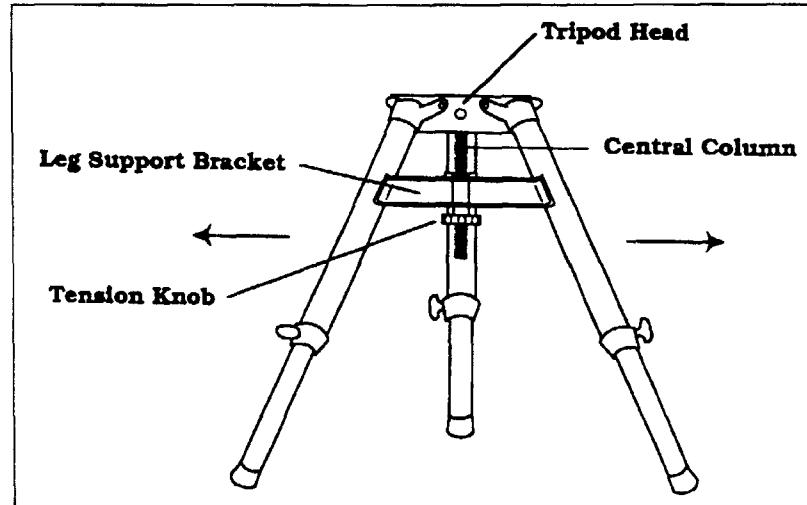


Figure 3-1 The field tripod completely set up.

---

## Adjusting the Tripod Height

The tripod that comes with your Ultima 2000 telescope is adjustable. To adjust the height at which the tripod stands:

1. Loosen the extension clamp on one of the tripod legs (see figure 3-2).
2. Extend the leg to the desired height.
3. Tighten the extension clamp to hold the leg in place.
4. Repeat this process for each of the remaining legs.

You can do this while the tripod legs are still folded together.

Remember that the higher the tripod legs are extended, the less stable it is. For casual observing, this may not pose a problem. However, if you plan on doing photography, the tripod should be set low to ensure stability. A recommended height is to set the tripod in such a manner that you can look directly into the eyepiece on the telescope with a diagonal while seated.

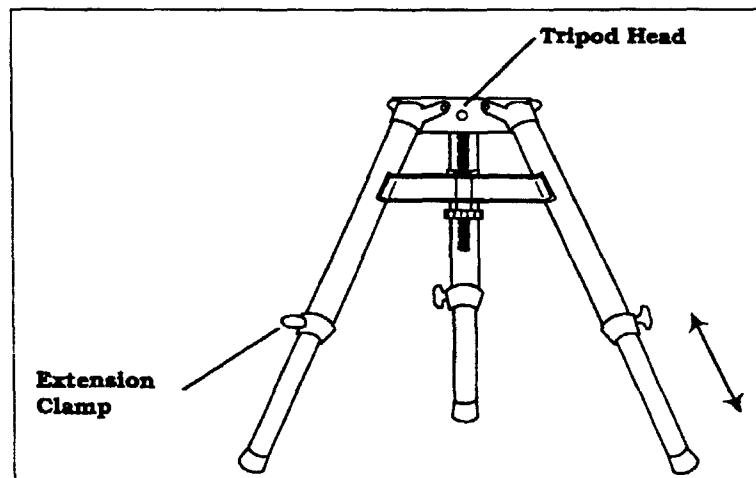


Figure 3-2

To adjust the height, loosen the extension clamps and slide the tripod legs to the desired height.  
Do not loosen the leg clamps with the telescope on the tripod.

## Attaching the Telescope to the Tripod

The telescope is fully assembled and ready to attach directly to a tripod or to an optional equatorial wedge. To attach the telescope to the tripod:

1. Align the center hole on the bottom of the telescope with the center post on the tripod. Lower the telescope onto the tripod.
2. Rotate the drive base on the tripod in order to line up the three holes of the telescope drive base with the three holes of the tripod head. The larger holes in the tripod head are for the extended screws that attach the bolts to the tripod directly (see Figure 3-3b).
3. Insert the three extended screws into the bottom of the tripod head through the three holes.
4. Thread the three extended screws into the holes until tight (see Figure 3-3b).
5. Tighten the bolts until the telescope is secure.

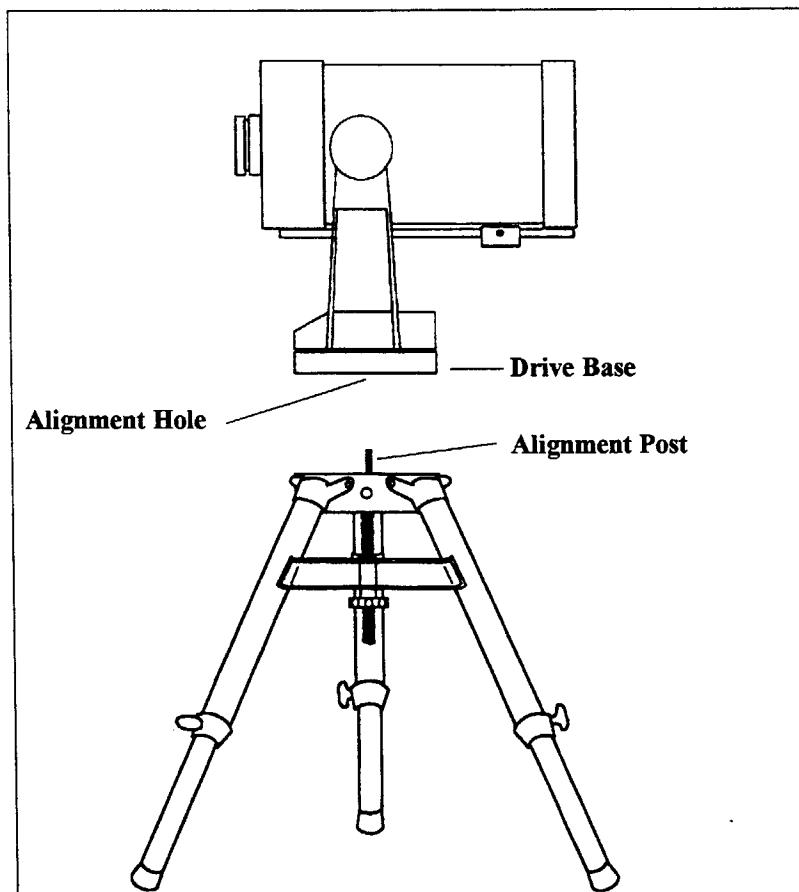
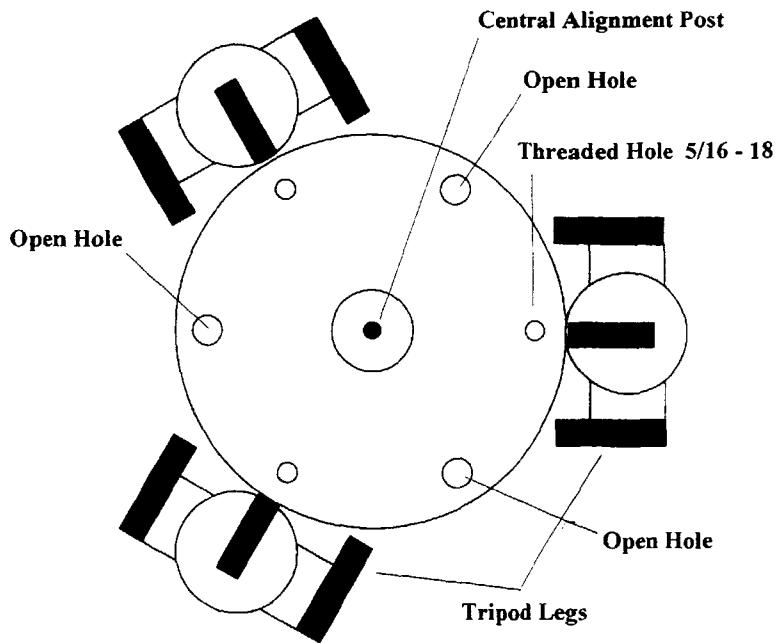


Figure 3-3a



**Figure 3-3b: Top view of the tripod head. Place the Ultima 2000 on top of the tripod. Use the open holes to mount the Ultima 2000 to the tripod.**

---

## Installing the Finder

The finderscope is used to help you locate and center objects in the main field of your telescope. To start, remove the finder and hardware from the plastic wrapper. Included are the following:

- 7x50mm Finderscope
- Finder Bracket
- Rubber O-ring
- Three Nylon-Tipped Thumbscrews (10-24x1/2")
- Two Phillips Head Screws (8-32x1/2")

Mounting the finderscope and bracket is a two step process; first mount the bracket to the telescope, then mount the finderscope in the bracket.

---

### *Attaching the Finderscope Bracket to the Telescope*

1. Find the two holes in the rear cell of the telescope (see Figure 3-4).
2. Remove the tape covering the two holes. The tape is there to prevent dust and moisture from entering the optical tube before installing the finder bracket.
3. Place the finder bracket over the holes. The bracket should be oriented so that the ring with the holes for the adjustment screws is closer to the rear cell of the telescope .
4. Thread the screws in by hand and then tighten fully.

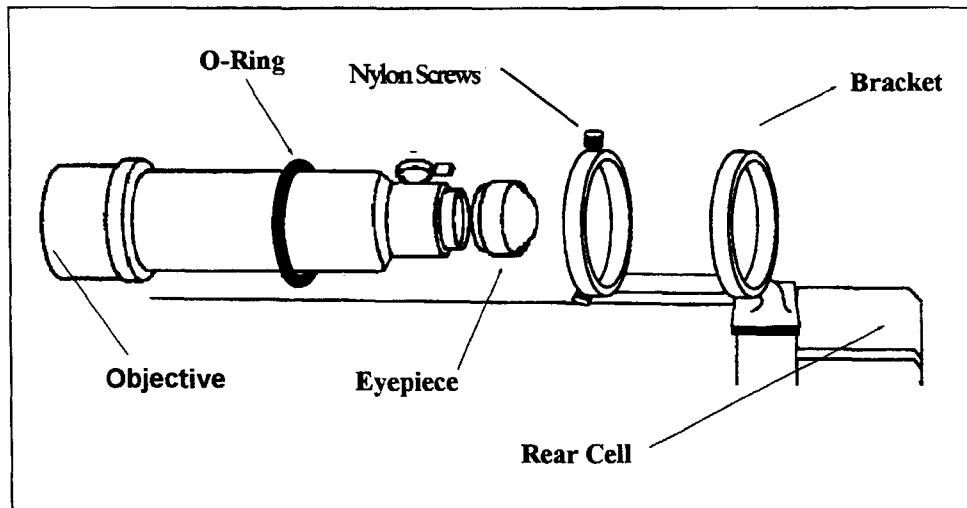
**WARNING:** If you remove the finderscope, do not thread the screws back into the rear cell of the telescope. The screws are long enough to obstruct the movement of, and possibly chip the primary mirror.

### ***Attaching the Finder to the Bracket***

---

With the bracket firmly attached to the telescope, you are ready to attach the finder to the bracket. See Figure 3-4 for a visual aide.

1. Thread the three nylon screws into the front ring of the finder bracket. Tighten the screws until the nylon heads are flush with the inner diameter of the bracket ring. Do NOT thread them in completely or they will interfere with the placement of the finder.
2. Slide the O-Ring over the back of the finder (it may need to be stretched a little).
3. Position the O-Ring on the main body of the finder so that it is toward the front (i.e., objective) end of the finder.
4. Slide the end of the finder where the eyepiece mounts into the front of the bracket. Push it back until the end of the finder, where the eyepiece attaches, is past the back ring of the bracket, but NOT so far that the O-Ring is snug inside the back ring.
5. Slide the O-Ring toward the back(i.e., eyepiece end) of the finder.
6. Push the finder back until the O-Ring is snug inside the back ring of the finder bracket.
7. It may be necessary to push the O-ring into the bracket recess with the tip of one of the set screws.
8. Hand tighten the three nylon-tipped thumbscrews until snug.



**Figure 3-4**

---

## Focusing the Finderscope and Reticle

The finderscope can be focused by loosening the locking ring, on the front of the finder, then rotate the front cell. When you have reached the desired focus, turn the locking ring so it pushes against the front cell. This locks the focus. See Figure 3-5.

To focus the reticle, rotate the eyepiece

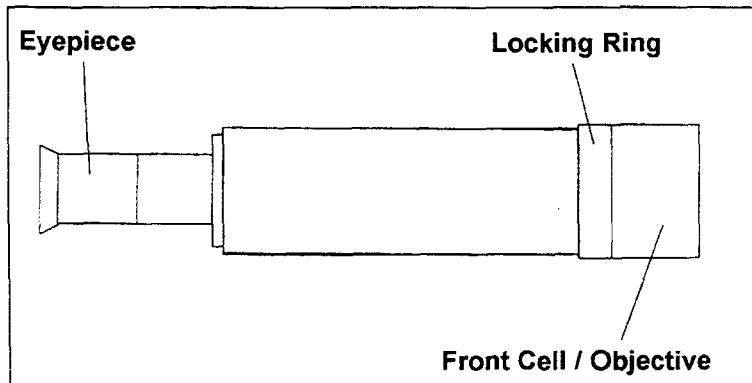


Figure 3-5

---

## Aligning the Finderscope

The Ultima 2000 comes with a 7x50mm finderscope. The finderscope is designed to help you find alignment stars and for terrestrial use of a wide field. The first number used to describe the finderscope is the power. The second number is the diameter of the objective lens in millimeters. So the 7x50 finderscope is 7 power and has a 50mm objective lens. Incidentally, power is always compared to the unaided human eye. So, a 7 power finderscope magnifies images seven times more than the human eye.

To make things a little easier, you should align the finderscope during the day when it is easier to locate objects. To align the finderscope:

1. There is no need to turn on the telescope for this procedure.
2. Choose a conspicuous object that is over 500 yards away. This will eliminate any possible parallax effect.
3. Point your telescope at the target and center it in the eyepiece of the telescope.
4. Check the finderscope to see where the object is located in the field of view.
5. Adjust the screws on the finder bracket, tightening one while loosening another, until the cross hairs are centered on the target.
6. Tighten each screw an additional quarter of a turn until you are sure they will not come loose easily.

Accurate alignment of the finderscope will make it much easier to find objects in the main optical tube.

---

## Attaching the Visual Back

The visual back allows you to attach most visual accessories to the telescope (see Figure 3-7). To attach the visual back:

- Remove the rubber cover on the rear cell.
- Place the knurled slip ring on the visual back over the threads on the rear cell.
- Tighten by rotating the slip ring clockwise until tight.

Once this is done you are ready to attach other accessories such as eyepieces, diagonal prisms, etc.

If you want to remove the visual back, rotate the slip ring counterclockwise until it is free of the rear cell.

---

## Attaching the Star Diagonal

The star diagonal is a prism that diverts the light at a right angle from the light path of the telescope. For astronomical observing, this allows you to observe in positions that are more comfortable than if you were to look straight through. To attach the star diagonal:

1. Turn the thumbscrew on the visual back until its tip no longer extends into or obstructs the inner diameter of the visual back.
2. Slide the chrome portion of the star diagonal into the visual back.
3. Tighten the thumbscrew on the visual back to hold the star diagonal in place.

If you wish to change the orientation of the star diagonal, loosen the thumbscrew on the visual back until the diagonal rotates freely. Rotate the diagonal to the desired position and tighten the thumbscrew. For best results, rotate the diagonal in the same position as you had it when you did your star alignment. This will maintain pointing accuracy.

---

## Attaching the Eyepiece

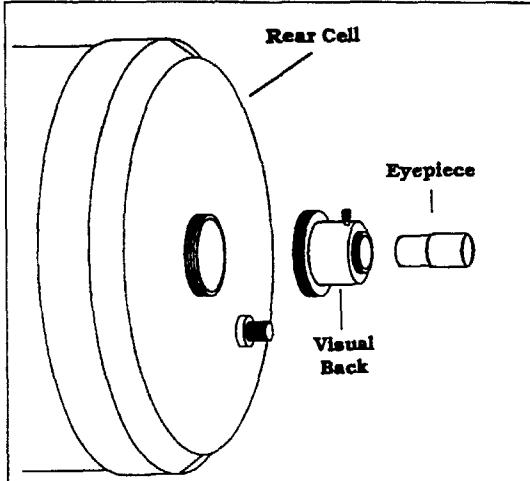
The eyepiece, or ocular, is the optical element that magnifies the image focused by the telescope. The eyepiece fits either into the visual back directly or into the star diagonal. To install an eyepiece into a diagonal:

1. Loosen the thumbscrews on the star diagonal so that it does not obstruct the inner diameter of the eyepiece end of the diagonal.
2. Slide the chrome portion of the eyepiece into the star diagonal.
3. Tighten the thumbscrew on the diagonal to hold the eyepiece in place.

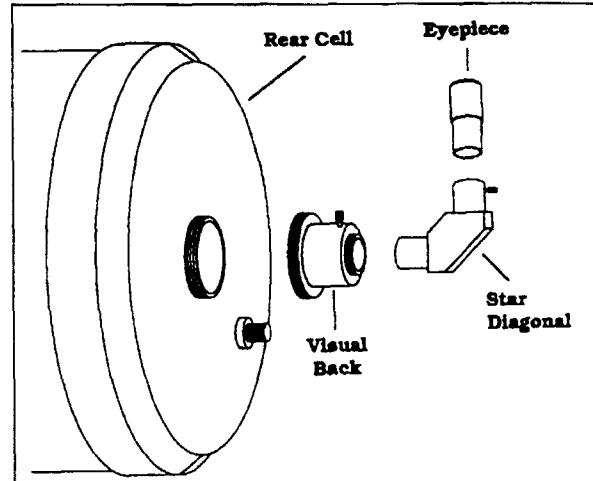
To remove the eyepiece, loosen the thumbscrew on the star diagonal and slide the eyepiece out.

Barrel diameter is the diameter of the barrel that slides into the star diagonal. Standard barrel diameters are .96", 1.25", and 2". The Ultima 2000 comes standard for use with 1.25" barrel eyepieces.

In addition to barrel diameter, eyepieces are also referred to in terms of their focal length. The focal length of each eyepiece is printed on the eyepiece barrel. The longer the focal length (i.e., the larger the number), the lower the eyepiece power and the shorter the focal length (i.e., the smaller the number), the higher the magnification. Generally, you will use low-to-moderate power when viewing. For more information on how to determine power, see the section on "Calculating Magnification."



**Figure 3-6**  
**Image will be upside down**



**Figure 3-7**  
**Image will be right side up but reversed**

## Balancing the Telescope

**Balance is a necessity for proper use of any telescope.** Balancing maximizes tracking accuracy and lessens vibrations in all telescopes. The Ultima 2000 is a precision instrument and so it is assumed that the user will balance the system. The clutches are designed to only tighten a certain amount. This protects the precision gears driving the telescope. Heavy stresses on the worm block assembly can cause damage.

The Ultima 2000 comes with a balance system that allows the telescope to be dynamically balanced (rotate the tube anywhere and it remains balanced). Most balance systems sold today only balance the telescope for a range of  $\pm 10\text{--}20^\circ$ . The Ultima 2000 balance system balances the telescope for all  $360^\circ$ .

To balance the telescope:

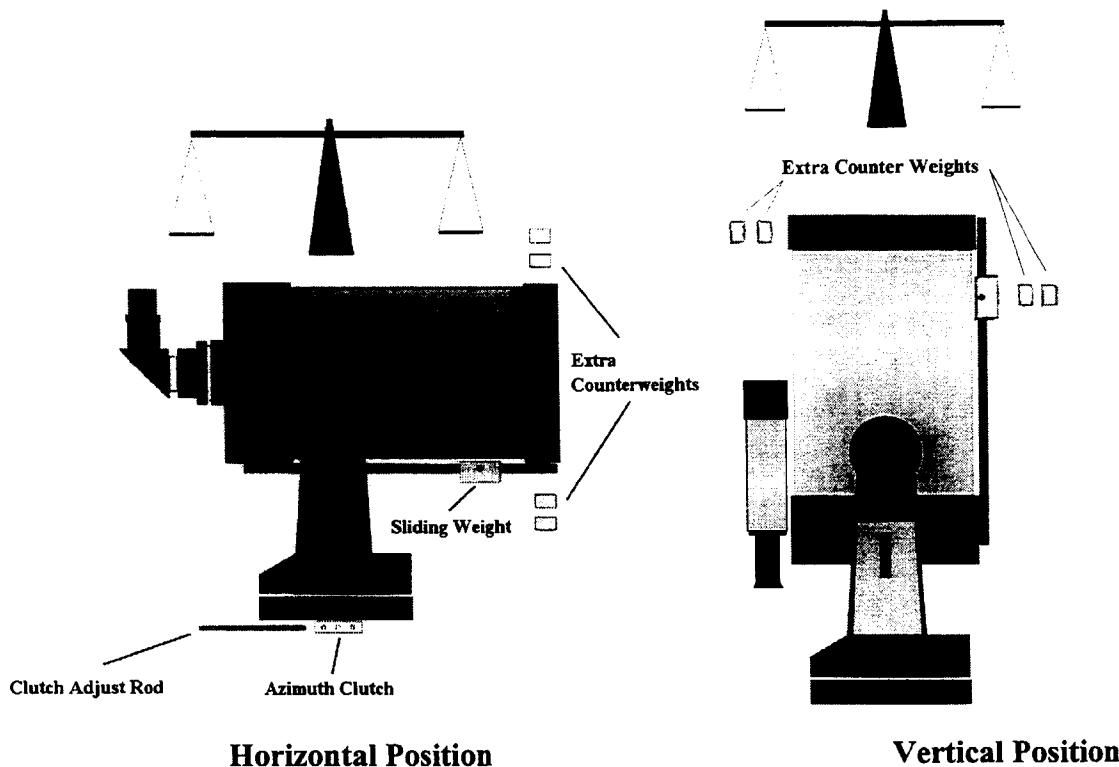
1. Put all the accessories on the telescope (i.e. visual back, diagonal, eyepiece, etc....). The finderscope must be mounted on the telescope.
2. Put the telescope in the horizontal position. See figure 3-8.
3. Hold the telescope and loosen the altitude clutch so the telescope rotates freely. (The altitude clutch is adjusted by turning the black knob located on the side of the larger fork arm, counter clockwise loosens and clockwise tightens). Don't let go of the telescope; it could rotate forward quickly and strike the downstop.
4. Slide the counterweight to a position such that the telescope does not rotate when you let go of it.
5. Tighten the nylon screw on the counterweight.

The Ultima 2000 is now dynamically balanced. If the counter weight is pushed all the way forward and the telescope still rotates up (so the front of the tube points up), then additional weights are needed. There are 4 accessory weights provided with the telescope and more optional weights are available through Celestron. The weights are small steel disks with a threaded hole on one side and a threaded rod on the other. This way the weights can be attached to each other. To add the extra weights:

1. Remove the screw on the top of the front cell of the telescope, near the Starbright Coatings Sticker.
2. Attach two of the weights to the front cell via the threads.

3. Place the two other weights under the sliding counterweight on the bottom of the telescope. The sliding counterweight has a threaded hole on its bottom face. To maintain a dynamic balance, equal weights must be added to the top and the bottom of the telescope; i.e., two on top of the tube and two on the bottom of the tube.
4. Put the telescope in the horizontal position. See figure 3-8.
5. Hold the telescope and loosen the altitude clutch so the telescope rotates freely. Don't let go of the telescope, it could rotate forward quickly and strike the downstop.
6. Slide the counterweight to a position such that the telescope does not rotate when you release it.

To maintain a dynamic balance, any extra weights added must be added in pairs, one on the top of the tube and one on the bottom. See Figure 3-8.



**Figure 3-8**

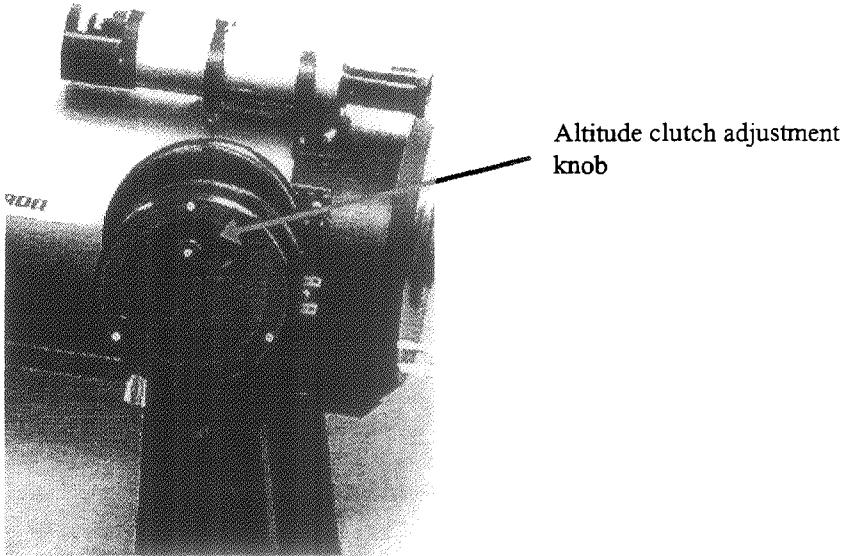
A telescope balances much like a scale. You need as much weight in the front as you have in the back. The sliding weight allows for adjustability. If the sliding weight is adjusted all the way forward and more weight is needed, use the extra counterweights provided with the telescope. Two weights should be placed on the top of the tube and two placed under the sliding weight on the bottom. When the telescope is pointed in the vertical position, there must be equal amounts of weight on the top and on the bottom (when the tube is pointed up, the top of the tube becomes the left side of the scale and the bottom becomes the right side of the scale). Notice that when the sliding weight is moved with the tube pointed straight up, the weight on the right side of the scale does not change.

## Adjusting the clutches

The Ultima 2000 has a dual axis clutching system. A clutching system is a necessity for two reasons. First it is convenient. You can move the telescope without unlocking any of the axis. Second, it protects the precision worm assemblies that drive the telescope. If there is too much load placed on a telescope without a clutch, the worm assemblies feel all the force. This can easily damage the telescope. The clutch is designed to slip when the telescope is too much out-of-balance or if a force is being applied to the system.

There is an ideal clutch setting for the telescope. For normal visual observing, you want to set the clutch as loose as possible. This makes it easy for you to move the telescope by hand and also extends the battery life by creating less resistance when the telescope is slewing. If you are doing CCD imaging or astrophotography, then you will want to tighten the clutches to about 75%. When the clutch is this tight it will be difficult to center objects by hand so the hand control should be used. Here is how to adjust the Altitude and the Azimuth clutches.

### *Altitude clutch*



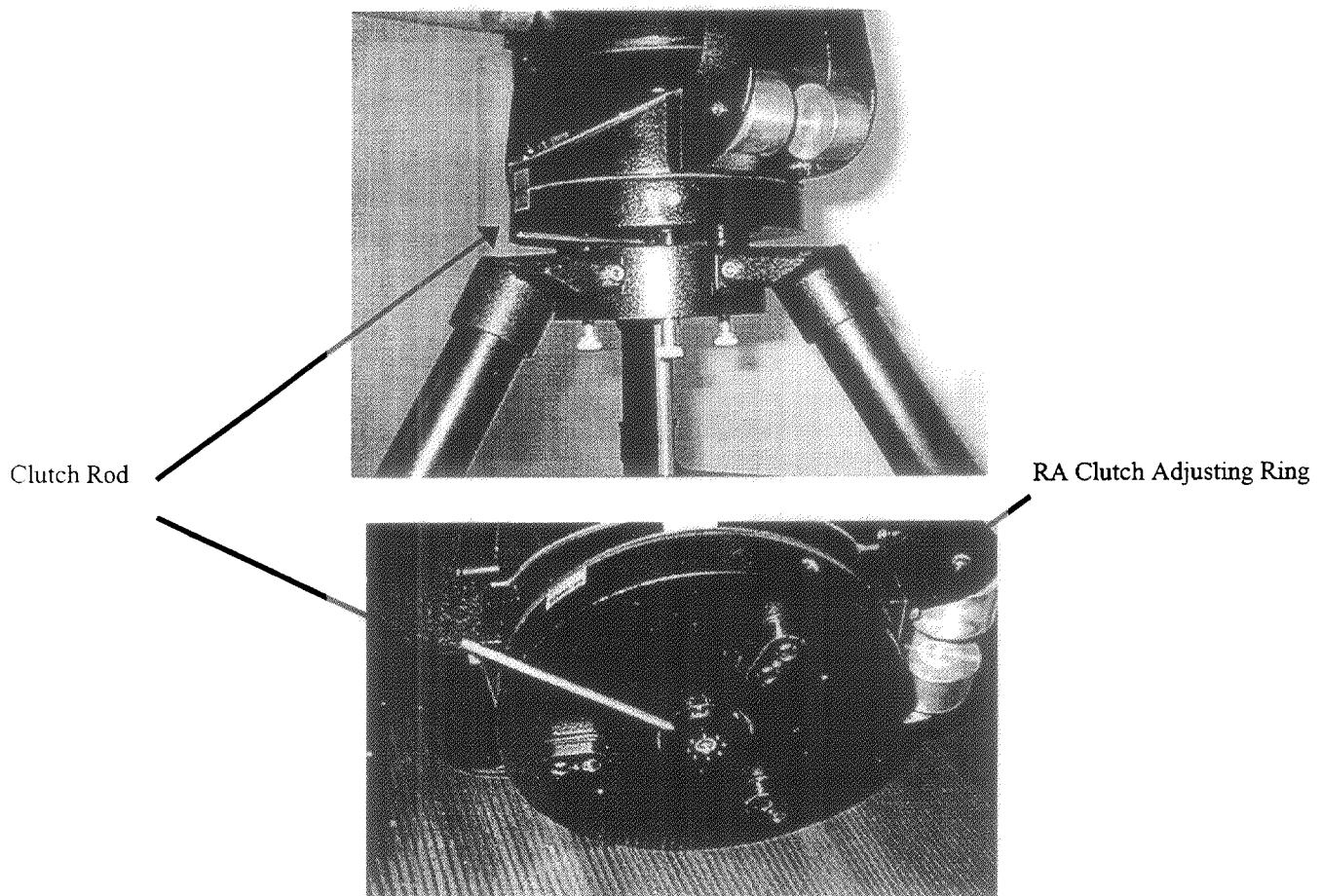
**Figure 3-9 - The Altitude clutch adjustment knob**

To tighten the altitude clutch, turn the Altitude Clutch Adjustment knob clockwise. To loosen, turn it counter-clockwise. There are stops placed on the adjustment knob. The full range of the clutch knob is about 360°. This will prevent you from over tightening the system.

### Azimuth clutch

---

To change the azimuth clutch tension, place the clutch rod into the RA clutch adjusting ring shown in Figure 3-10. To tighten the clutch turn the rod counter-clockwise when looking down on the telescope. The clutch rod allows for about 110° of motion which is more than enough motion to adjust the range of clutch tensions needed. There are stops placed on the RA clutch ring. This will prevent you from over tightening the system.



**Figure 3-10**

**The azimuth clutch adjustment location shown in two views, side and from underneath the drive base.**

## Attaching an Equatorial Wedge to the Tripod

The Ultima 2000 attaches to an optional equatorial wedge, 93655, so it can be used for astrophotography or CCD imaging. It is a good idea to purchase the Deluxe Latitude Adjuster kit (DLA), 93662, in addition to the wedge. This aids in getting an accurate polar alignment.

The tripod has six holes on its head for mounting equipment. Three of the holes are threaded with 5/16-18 threads and three of the holes are open. The three open holes are for mounting the Ultima 2000 telescope to the tripod directly for altazimuth use. This procedure is covered earlier in this chapter. To mount the wedge to the tripod, the through holes need to have threads. This is accomplished with inserts provided with the wedge. The inserts are placed in the through holes from the bottom side of the tripod head. With the inserts in place, all of the holes are threaded. Now you can attach the wedge.

To attach the wedge to the tripod (Figure 3-11):

1. Place the black metallic inserts in the open holes from underneath the tripod head. The inserts fit into the tripod head with the flange end down.
2. Hold the wedge over the center post on the tripod.
3. Rotate the wedge so the through holes of the wedge line up with the threaded inserts in the tripod head. Notice that there is a pin on the bottom of the wedge which protrudes from the azimuth adjusting block. The pin fits into one of the existing threaded holes. You may need to rotate the wedge slightly back-and-forth to get the azimuth block pin to fall into the existing threaded hole on the head of the tripod.
4. Use the 5/16-18 bolts and the washers provided with the wedge to attach the wedge to the tripod.

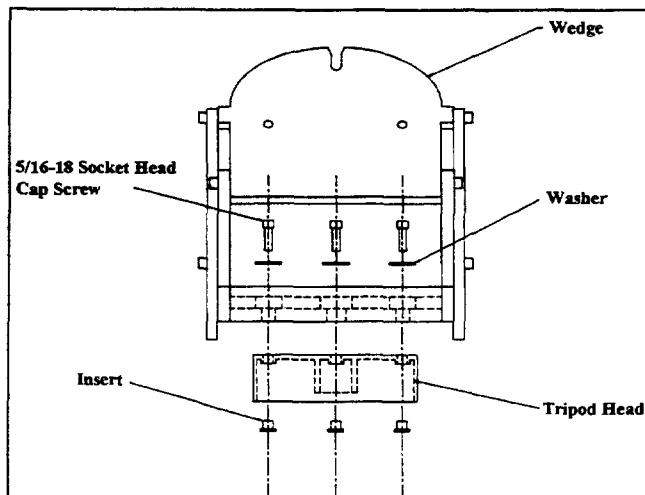


Figure 3-11 - Front exploded view of the wedge and tripod head.

---

## Attaching the Ultima 2000 to a Wedge

Once the wedge is firmly attached to the tripod, you are ready to mount the telescope on the wedge. The telescope base fits directly onto the tilt plate of the wedge. To mount the telescope on the wedge:

1. Lay the telescope on its side and locate the three feet underneath the drive base. Each foot has two threaded holes. The holes furthest away from the center are the ones you need to use.
2. Partially insert one of the three (3/8-16x1.25") hand tightening knobs into one of the threaded holes.
3. Pick the telescope up by the fork tines and position it above the tripod. It should be oriented so that the telescope is over the tripod with the base pointing toward the tilt plate (see Figure 3-12).
4. Slide the bolt, that is attached to the drive base, into the slot on the top of the tilt plate.
5. Tighten the bolt slightly so that the bottom of the drive base is flush to the tilt plate. Do not tighten it fully or you will not be able to rotate the base enough to insert the two remaining bolts. (If you do not tighten the bolt at all, the drive base may be tilted slightly, preventing the remaining two bolts from threading straight in.)
6. Move the base of the telescope side-to-side until the two remaining holes in the drive base line up with the holes in the tilt plate on the wedge.
7. Insert the screws and tighten all three completely. There is no need to loosen these until you are ready to remove the telescope from the wedge.

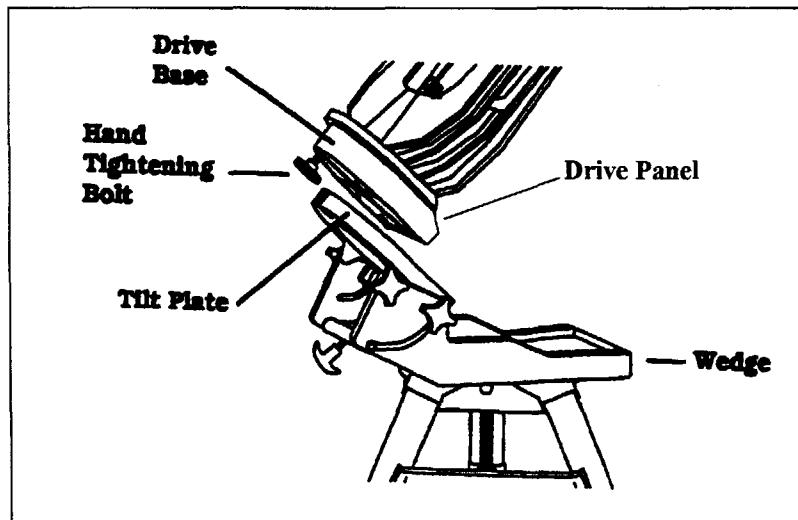


Figure 3-12

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## Inserting the Batteries

Use only **alkaline** batteries in your Ultima 2000. To insert the batteries:

1. Open the battery cover located on the base by pressing the recessed tab on the lid and lifting.
2. Remove old batteries (if necessary).

3. Insert 4 alkaline AA batteries into each battery compartment.
4. Close the battery compartment lid and press down until it snaps shut.

**NOTE: The use of non-alkaline batteries may cause improper functioning of your Ultima 2000.**

---

## **Storing Your Ultima 2000**

When not in use, all lenses and eyepieces should be covered. This will reduce the amount of dust build-up on all optical surfaces and reduce the number of times you need to clean the instrument. You may want to return everything to its original shipping container and store it there. If this is the case, all optical surfaces should still be covered to prevent dust accumulation. It is a good idea to remove the batteries when storing the telescope for long periods of time.

The Hand Control allows you to control the telescope and specify various parameters. To use, insert the batteries in the telescope drive base (see the section, Inserting the Batteries, in the Assembly chapter). This section gives details on all the different menus and sub-menus of the Ultima 2000 hand control.

## Buttons for the Hand Control

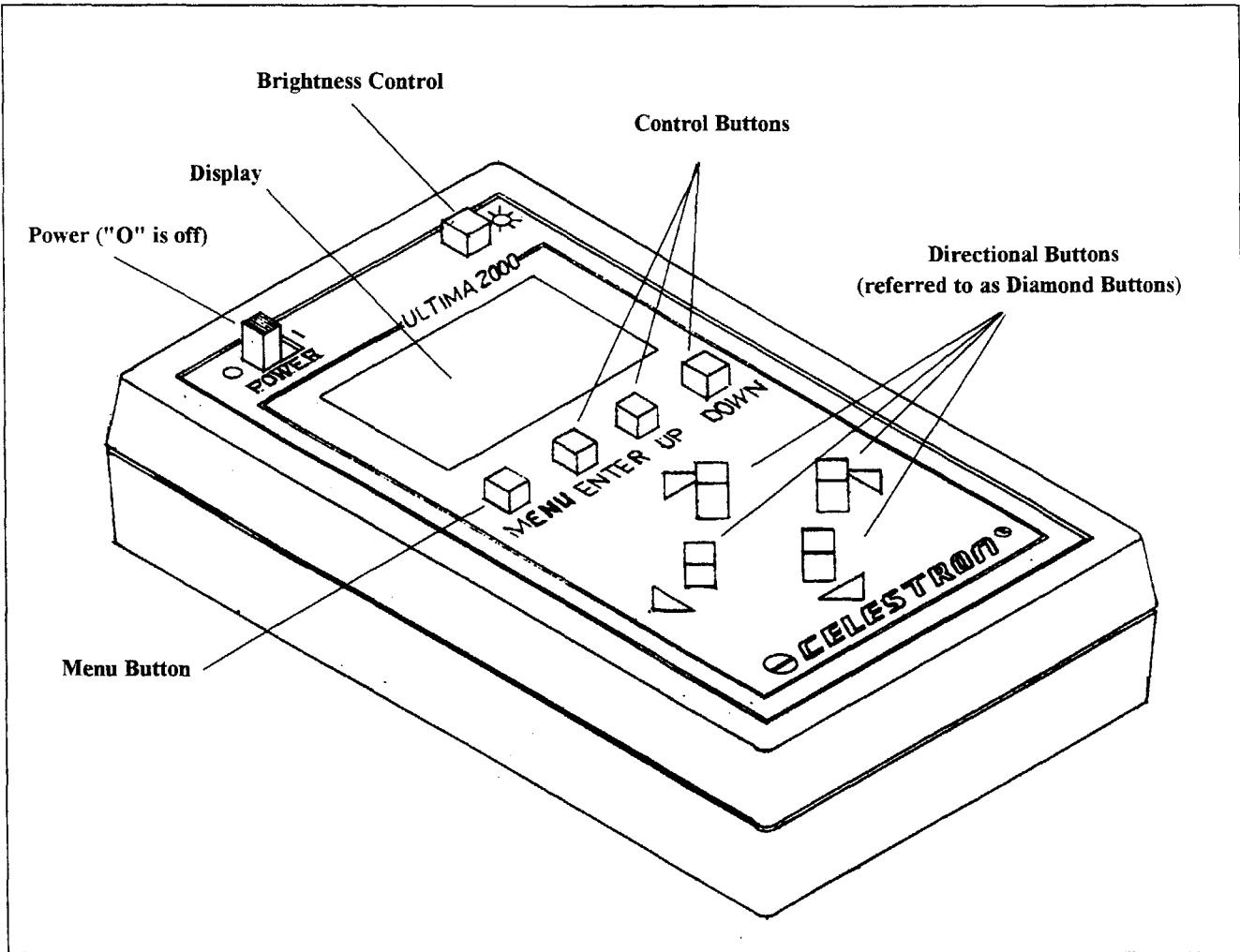


Figure 4-1

The hand control is quite simple. There are 4 buttons for the interface controls, 4 buttons for moving the telescope, and a display screen. The interface is a list of 8 menus with each menu having several sub-menus.

Here is what each button on the hand control is for:

|                   |  |
|-------------------|--|
| <b>POWER</b>      | Turns the power of the hand control on and off. The "O" is the off position. When the telescope is aligned and tracking the sky, the hand control can be turned off and on and it will not affect the telescopes alignment. This feature can be used to save battery life when leaving the telescope ON overnight. |
| <b>BRIGHTNESS</b> | There are 5 different brightness settings for the display screen. This button changes the brightness of the display.   |
| <b>MENU</b>       | Returns the display to the main menu from anywhere in the software.  |

#### ***Control Buttons***

---

|              |   |
|--------------|---|
| <b>ENTER</b> | Used to enter into a menu or select an item from a list.        |
| <b>UP</b>    | Used to scroll through the list of menus or through a sub menu. |
| <b>DOWN</b>  | Used to scroll through the list of menus or through a sub menu. |

#### ***Diamond Buttons***

---

These four buttons move the telescope. If in Slewing or Finder rates the telescope will move in the direction the arrows are pointing. If the speeds are set at Center, 2X Sidereal, or Photo, the buttons cause the object in the eyepiece to move in the direction the buttons are pointed. (This is assuming you are using a diagonal.)

---

## **Main Menu**

The user interface of the Ultima 2000 consists of eight main menu items. Each of these has sub menus.

- Menu ALIGN, for aligning the Ultima 2000 to catalog objects.
- Menu GO TO, for commanding the telescope to move to a selected catalog object.
- Menu CATALOG, for choosing objects out of a catalog.
- Menu POSITION, for finding the R.A. and DEC position, the relative position, or the constellation to which the telescope is pointing.
- Menu IDENTIFY, for identifying unknown objects.
- Menu TIMER, for performing stopwatch functions.
- Menu SETUP, for setting up scroll rate, motor speeds, mode of operation and other user functions.
- Menu TOUR, for touring special objects for a given month of the year.

## **Navigating through the Menu**

The user interface is basically sets of menus and sub-menus. When you turn the telescope ON, you are in the main menu. The first menu item that comes up in the display is,

MENU  
ALIGN

Notice that the “A” is blinking. (Note, a blinking item on the display will be shown as a bold letter in this manual). A blinking item is a prompt to use any one of the control buttons (ENTER, UP, or DOWN). If you press ENTER, you will enter into the ALIGN menu. If you press UP or DOWN, you will scroll through the other seven main menu items.

Here are some examples of how to use the interface.

### ***Scrolling Through the Menu***

| <b><u>BUTTON or ACTION</u></b>          | <b><u>NOTES</u></b>                                   | <b><u>DISPLAY</u></b> |
|---|---|-----------------------|
| Turn On<br>(telescope and hand control) | The telescope always starts off in the<br>ALIGN menu. | MENU<br>ALIGN         |
| DOWN                                    | Scrolling to different items in the<br>main menu.     | MENU<br>GO TO         |
| DOWN                                    | Scrolling to different items in the<br>main menu.     | MENU<br>CATALOG       |
| DOWN 4 times                            | Scrolling to different items in the<br>main menu.     | MENU<br>SETUP         |
| UP 6 times                              | Scrolling back to the original item                   | MENU<br>ALIGN         |

### ***Entering and Exiting a Menu***

| <b><u>BUTTON or ACTION</u></b>                      | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b> |
|---|---|-----------------------|
| Turn the telescope ON and scroll to<br>MENU CATALOG |   | MENU<br>CATALOG       |
| press ENTER   | Entered into the CATALOG menu.<br>The “S” is blinking so we can press<br>ENTER or UP/DOWN | NAMED<br>STAR         |
| press ENTER   | Entered into a list of named stars.<br>Scroll UP or DOWN to find other<br>stars.          | 0138-572<br>ACHERNAR  |
| press DOWN 12 times                                 | Scrolled to a star named Betelgeuse.  | 0555+074<br>BETELGEU  |
| press MENU  | Puts you back to the main menu  | MENU<br>CATALOG       |

## *Looking Up a Messier Object*

---

| <u>BUTTON or ACTION</u>                          | <u>NOTES</u>   | <u>DISPLAY</u>                  |
|--|--|---------------------------------|
| Turn on the telescope and scroll to MENU CATALOG |  | MENU<br>CATALOG                 |
| press ENTER                                      | Entered into the CATALOG menu. The "S" is blinking so we can press ENTER or UP/DOWN  | NAMED<br>STAR                   |
| press UP 4 times                                 | Scrolled to the Messier catalog. Let's look at M42. The "M" is blinking  | M 001                           |
| press ENTER                                      | Enter into the Messier catalog. The leading "0" is blinking. We want M 042 so press enter to except the leading zero.  | M 001                           |
| press ENTER                                      | Now the second zero is blinking indicating that it can be edited by using the UP/DOWN Buttons.   | M 001                           |
| press UP 4 times                                 | Adjusted the second number to 4.   | M 041                           |
| press ENTER                                      | Accepted the value "4" and now we are able to adjust the last digit via the UP/DOWN buttons  | M 041                           |
| press UP   | Change "1" to "2".   | M 042                           |
| press ENTER                                      | Gives the position of M42  | 0535-055<br>M 042               |
| press ENTER                                      | The display reads GO TO with the "G" blinking and scrolls information about the object. When the scrolling is complete, the screen returns to the previous screen. (Note: if you hit enter while the display is scrolling, the telescope will slew to the object.) Don't do this now because the telescope is not aligned. | GO TO<br>(scrolls object info.) |
| press MENU                                       | Returned to the main menu.   | MENU<br>CATALOG                 |

---

## Description of each Menu

### *Menu ALIGN*

---

This menu is the first menu to be displayed when the telescope is turned on. There are five sub menus under ALIGN. Each of these is a different way to align the telescope. Here are the sub menus:

**SKY** This is used for the initial Alt-Az two star alignment or updating your alignment during the evening. If you are looking at a non-stellar object, you can center the object and update your alignment in this mode.

**NOTE:** The Ultima 2000 uses two stars to align to the sky. If you align to two stars then later align to a third, the telescope overrides the closer of the two original alignment stars. This maximizes the distance between your alignment objects, even if you update your alignment with many objects in one part of the sky. Alignment stars should be more than 20° apart.

**EARTH** This is used to align to terrestrial objects that you have defined in the NEW Catalog database (example given in Chpt. 8). Terrestrial objects don't move as the night progresses, so in this mode the positions of the objects are not updated with time. In Earth mode, the telescope assumes the objects are not moving. An example is given in Chapter 8.

**CHANGE** This mode allow the user to choose which alignment star he/she wishes to replace with a third star. The Ultima 2000 uses two stars for its alignment to the sky. These stars remain in the memory until you update it with a new alignment star. This setting allows you to view the names of the stars the Ultima 2000 is aligned to. You may have reason to replace one alignment star over another. This mode gives you the choice. An example is given in Chapter 8.

**EQ SOUTH** Use this setting in the Southern hemisphere with a polar aligned telescope. The polar alignment accuracy is critical. The telescope implicitly uses the celestial pole for one of the alignment objects. This way you only need one star to align the telescope. This setting is useful for telescopes permanently mounted or being used remotely. A wedge is necessary.

**EQ NORTH** Use this setting in the Northern hemisphere with a polar aligned telescope. The polar alignment accuracy is critical. The telescope implicitly uses the celestial pole for one of the alignment stars. This way you only need one star to align the telescope. This setting is useful for telescopes permanently mounted or being used remotely.. A wedge is necessary.

When you first attempt to align the telescope to the sky, you are prompted to set the telescope to its downstops. This sets the position of the encoders. There is a downstop for each axis, azimuth and altitude.

The azimuth downstop is referenced by two stickers on the drive base. Rotate the fork arms until the stickers are lined up.

The altitude downstop position is with the telescope tube pointed down. In this position, the pin on the front of the tube presses flush against the pin on the fork arm. Gently move the tube down until it hits its stop. **Don't slam the two downstop pins together; this could damage the pins.**

When you first press ENTER at the ALIGN menu, the screen scrolls,

INITIALIZING.....

Then the display will read,

SET FORK  
TO ZERO

This is your cue to rotate the telescope in azimuth until the two stickers on the drive base line up. Then press ENTER. Next the display will read,

TUBE TO  
DOWNSTOP

Now move the telescope tube to the downstop position (pointing down). Press ENTER. The display places you into the SKY align menu. The display will look like this,

SKY  
ACHERNAR (this will show the catalog object last displayed in the CATALOG menu)

Use the UP/DOWN buttons to scroll through the different ALIGN menu settings (SKY, EARTH, ETC...). Press ENTER when you decide which alignment method you wish to use. The display will now read,

SKY  
ACHERNAR

with the "A" blinking. You can use the UP/DOWN buttons to scroll to different alignment objects until you have reached the desired object. Center the telescope on the object and press ENTER. You have just aligned to your first alignment star. Align the telescope to another star to complete the alignment procedure (an example is given in Chapter 8).

#### ***Menu GO TO***

---

This menu tells the telescope to go to the last object displayed in the Catalog Menu. GO TO has three sub menus. Use the UP or DOWN arrows to scroll to the different sub menus. Here is an explanation of each.

AUTO: Press ENTER here to have the telescope automatically slew to the last object accessed in the Catalog menu.

MANUAL: Press ENTER here and the display will tell you how far and in what direction the telescope should move to center the object. Press ENTER again and the information about the object will scroll across the screen. If you press ENTER while the screen is scrolling, the telescope will slew to the object.

You can also move the telescope by hand to the object. The guide arrows that tell you how far away you are from the object will guide you to the object.

RELATIVE: This GO TO feature is an even more precise way of finding non-stellar objects. This option is to ensure that an object is in the field of view of a CCD chip or a medium power eyepiece. When you press ENTER from this setting, the computer searches through a database of stars to find the brightest star within 5° of the faint object. The display will prompt you to center the object. After you have centered the object, using the Diamond Buttons, press ENTER. The telescope will slew to the original object sought.

#### ***Menu CATALOG***

---

This menu is very extensive. You may scroll through the list of catalogs with the UP and DOWN buttons; pressing ENTER selects a particular catalog for you to scan. Catalogs can be accessed in two ways. You may scroll through the items or you may input a particular object. Once an object is selected, press ENTER to get a description of type, size, magnitude, and chart number. Press ENTER twice and the Ultima 2000's built-in high speed motor drive system will locate the object for you, typically in 10 seconds or less.

The CATALOG menu contains the following: a Star Catalog (ST) which is unique to the Ultima 2000, the Messier Catalog (M), the Revised New General Catalog (RNGC), Non-Stellar Catalog (NS), portions of the Index Catalog (IC), portions of the European Southern Observatory (ESO) Catalog, portions of the Uppsala General Catalog (UGC), a user definable catalog (NEW), and the PLANETS listed in order by increasing distance from the Sun. When used in conjunction with the GO TO function, the Ultima 2000 will guide you to any of the more than 10,000 objects in its database. There is a description of each catalog in the following section.

The "S" blinks, indicating that the catalog selection can be changed. Press the DOWN button to scroll through the various catalog and planet selections. The order and explanation is as follows:

| DISPLAY      | DESCRIPTION                                 |
|--------------|---|
| NAMED STAR   | List of Stars by Name, mainly for alignment |
| NEW01        | User Definable Catalog (NEW)                |
| U00148       | Uppsala General Catalog (UGC)               |
| E263-48      | European Southern Observatory Catalog (ESO) |
| NS141        | Non-Stellar Catalog (NS)                    |
| IC434        | Index Catalog (IC)                          |
| NGC4565      | Revised New General Catalog (RNGC)          |
| M013         | Messier Catalog (M)                         |
| ST055        | Star Catalog (ST)                           |
| SOLAR SYSTEM | Planets Catalog                             |
| NAMED OBJECT | List of popular objects by name             |

Any time the catalog selection is changed, the first letter of each catalog abbreviation will blink.

As an example, if you want to select star 55 you will need to enter the number 055. Leading zeros in a catalog number must be entered. Press ENTER and the catalog abbreviation will stop blinking and the first character of the catalog number will start blinking. Once again, this indicates that this number can be changed. Press the ENTER button again and now the second digit will blink. Press the UP button until the number "5" displays, then press ENTER. The last digit will blink. Press the DOWN button until the "5" displays. (The UP button could have been pressed 5 times to achieve the same result.) Now press the ENTER button. The screen will display the catalog entry and the coordinates. Keep in mind that you enter one digit at a time.

After you have selected an object, press ENTER and the display will scroll from left to right. For our example the display will scroll:

ST055 MAG= 0.5 SIZE= \* ACHERNAR

ERADINUS STAR SA=24

The CATALOG menu provides the following information in this order:

ST Number: ST055

|                     |                 |
|---------------------|-----------------|
| Coordinates:        | 0138 -57.2      |
| Magnitude:          | +0.5            |
| Size or separation: | (if applicable) |
| Name:               | Achernar        |
| Constellation:      | Eridanus        |
| Description:        | Star            |
| Chart(SA or UA):    | SA=24           |

Once the scroll is finished, the screen will display the catalog designation and the coordinates. You can replay the information by pressing the ENTER button again. While the information is scrolling, the top part of the display will read GO TO. The leading "G" will be blinking. This indicates that you can press ENTER again and the telescope will slew to the object. The screen will display the catalog designation and the coordinates.

So, from the CATALOG menu, you can press ENTER twice and the Ultima 2000 will slew to the object for you.

If the object displayed is not the one you want, you may press the UP button to display the next entry for this catalog. You can scroll through the entire catalog in sequential order by pressing the UP button. Pressing the DOWN button scrolls through in reverse order. This only allows you to scroll items in the currently selected catalog. For example, if ST055 displayed while you pressed the UP button, the readout will display ST056. If you scroll through the end of the catalog, the readout will roll over and start with the first entry, ST001. If you scroll through the catalog backwards, once it reaches zero, it will roll over to the last entry in the catalog.

If an erroneous catalog number is entered (like M505 or RNGC 9000) the readout will automatically default to the first entry for that particular catalog (i.e., M001, ST001, RNGC0001, or NEW01). Also, each time you enter the catalog menu, the readout will display the last object accessed in either CATALOG, GO TO, or ALIGN menus.

In the SETUP menu you can use the CHART sub-menu to select which catalog you want the readout to display; either Sky Atlas 2000.0 or Uranometria.

### ***ST001 The Star Catalog (ST)***

The Star Catalog contains many interesting stars, double stars and red stars, including all of the alignment stars.

### ***M013 The Messier Catalog (M)***

This catalog contains 110 objects, those cataloged by Messier himself and several added later which Messier was known to have observed.

### ***NGC4565 The Revised New General Catalog (RNGC)***

The Revised New General Catalog (RNGC) contains 7840 non-stellar objects that came from the original catalog compiled by J. L. E. Dreyer and updated descriptions compiled by Steve Gottlieb.

### ***IC434 The Index Catalog (IC)***

The Index Catalog (IC) contains selections of objects that are not contained in the original New General Catalog.

## **NS141    The Non-Stellar Catalog (NS)**

The Non-Stellar Catalog (NS) contains objects not found in either the New General Catalog or the Index Catalog. In all, there are a total of 661 interesting objects.

### **E263-48       The European Southern Observatory (ESO) and**

### **U00148       Uppsala General Catalog (UGC)**

The European Southern Observatory (ESO) and the Uppsala General Catalog (UGC) contain still more objects not found in either the New General Catalog or the Index Catalog.

## **NEW01    The User Catalog (NEW)**

In addition to all the catalogs described thus far, the Ultima 2000 has a user definable catalog. Referred to as NEW, this catalog will accept up to 27 objects - planetary, deep sky, or terrestrial. You define the catalog designation and enter the coordinates. The user catalog is initially empty. You add the objects you want (i.e., favorite deep-sky objects, comets, variable stars, etc.). All information is stored in the nonvolatile memory which is retained when you turn your telescope off.

Once the NEW catalog designation displays, press the ENTER button. You may enter objects into the catalog in any order you wish by scrolling and selecting any number from 1 to 27. Press ENTER again and the display will read,

SET TO  
CUR POSITION

with the "S" blinking. If you press ENTER, the telescope will record the RA and DEC of the location the telescope is pointing. This defines the NEW object position. The other option is to press the Down button where the display will read,

NEW  
RA DEC

This allows you to put in an RA and DEC manually. Press ENTER and the default screen will read,

+00 00.0       (Declination in degrees and minutes)  
24 00 00       (Right Ascension in Hours Minutes and Seconds)

You are now ready to enter the coordinates—both right ascension and declination—for your first catalog entry. Press the ENTER button and the first character in the DEC coordinates will blink. Use the UP or DOWN button to change the character, in this case + or -. Once the correct character displays, press ENTER. The next character will blink indicating that it can be changed. Continue entering the coordinates one character at a time until all the coordinates have been entered.

## **SOLAR SYSTEM**

In addition to the thousands of deep-sky objects in the database, the Ultima 2000 contains the eight planets visible from Earth and also has the Sun. (**Do not view the Sun without a Solar Filter placed over the front of the telescope!**) The Ultima 2000 requires the date of your observing session. The date is entered one character at a time using the month-day-year format. The first two characters are for the month, the next two are for the day of the month, and the last two are the year. The readout will default to the last date entered. The date is stored in nonvolatile memory and does NOT have to be entered more than once each day.

When scrolling through the list, the first character of each planet's name blinks, indicating the selection can be changed. Once the planet you want to observe is displayed, press ENTER. The Ultima 2000 will display the coordinates for that planet based on the date entered. Coordinates are computed for Epoch 2000.0. The positions will be accurate through the twenty-first century.

Here is the Planetary Catalog under the SOLAR SYSTEM menu.

|         |                                    |
|---------|------------------------------------|
| DATE    | Requires entering the current date |
| SUN     | Sun                                |
| MERCURY | Mercury                            |
| VENUS   | Venus                              |
| MARS    | Mars                               |
| JUPITER | Jupiter                            |
| SATURN  | Saturn                             |
| URANUS  | Uranus                             |
| NEPTUNE | Neptune                            |
| PLUTO   | Pluto                              |

### ***Named Object***

This is a list of popular objects by name. It is sometimes convenient to look up an object by its name rather than its Messier or RNGC number. See Appendix A for the complete list of objects. To use this catalog, enter into the CATALOG menu and scroll down to the NAMED OBJECT catalog by using the UP or DOWN button. Press ENTER, to activate the catalog. Use the UP/DOWN buttons to scroll through the catalog. At any object, you can press ENTER and the display will scroll information about the object. While the information is scrolling, the top part of the display will read GO TO with the "G" blinking. This indicates that you can press ENTER again and the telescope will slew to the object. After the scrolling message has finished, the display will return to the object name and list its coordinates.

### ***Menu POSITION***

---

There are four choices under the POSITION menu. Three give you the direction the Ultima 2000 is pointed and one gives you information on the tracking motors. Here are the choices under POSITION.

|          |  |
|----------|--|
| RA DEC   | This gives the right-ascension and declination of the telescope. RA appears on the top of the display and DEC is on the bottom. The telescope must be aligned for this to be valid.  |
| TRACKING | This mode monitors the tracking motors. This displays a number for each tracking motor between -32768 and 32767. This can be used for setting the backlash compensation for each axis of the telescope. See the section on SETUP in this chapter.  |
| TELESCOP | This gives the relative direction the telescope is pointing compared to its downstop positions. The azimuth reads from 0 to 359° and the altitude reads from 0 to 90°. This does not give you the Alt-Az position. You must turn the telescope ON at the downstop positions or set the downstops through the alignment menu. |
| CONSTELL | This gives the constellation toward which the telescope is pointing. The telescope must be aligned for this to be valid.   |

Here is an example of how to use the POSITION menu.

| <b><u>ACTION</u></b>           | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b> |
|--------------------------------|---|-----------------------|
| Start off at the POSITION menu |   | MENU POSITION         |
| Press ENTER                    | Enter into the POSITION menu and view the first item in the list. | RA DEC                |
| Press DOWN                     | Scroll down to the next item                                      | TRACKING              |
| Press DOWN                     | Scroll down to the next item                                      | TELESCOP              |

|             |   |                       |
|-------------|---|-----------------------|
| Press DOWN  | Scroll to the next and last item  | CONSTELL              |
| Press ENTER | The telescope tells you what constellation it is pointed at. See the Appendix A for abbreviations.    | 2226-249<br>PSA 946   |
| Press ENTER | Returns you to the CONSTELL mode.   | CONSTELL              |
| Press DOWN  | Scroll down to the RA DEC mode  | RA DEC                |
| Press ENTER | Displays the RA and DEC of the direction the telescope is pointed in. RA is on top.                   | 02 50 13<br>- 56 36.0 |
| Press ENTER | Returns you to the RA DEC mode.   | RA DEC                |
| Press DOWN  | Scroll down to the next menu item   | TRACKING              |
| Press DOWN  | Scroll down to the next menu item   | TELESCOP              |
| Press ENTER | Displays the direction the telescope is pointed in Altitude and Azimuth. Azimuth is displayed on top. | 216.34<br>-088.89     |
| Press MENU  | Returns you to the main menu.   | MENU POSITION         |

#### ***Menu IDENTIFY***

---

This menu has two functions. First, it can be used to identify an object that you do not recognize. For example, if while sweeping the sky you stumble across an unknown object, you can use this menu to find its name. Second, it can be used to find another object close to the one you are currently observing. In either case the menu works the same.

You will need to enter two parameters when selecting an object. The first parameter is the object type or catalog, and the second is the magnitude range. The following object types and catalogs are available:

- NS Object from Non-Stellar Catalog
- ST Star from catalog
- GC Globular cluster
- OC Open cluster
- GX Galaxy
- PN Planetary Nebula
- NB Nebula
- 2\* Double star
- R\* Red or colored star

Use the ENTER, UP and DOWN buttons to enter and change these parameters. The hand control will display the object you have in view. When you move the telescope, the hand control displays the objects as they come into view.

#### ***Menu TIMER***

---

Included in the Ultima 2000 software is a timer mode that allows you to time images, photographs, eclipses, occultations, etc. Operated by pressing ENTER, the timer works like a stopwatch and elapsed time is not affected by accessing other modes.

## ***Menu SETUP***

---

This menu allows you to check the battery power, set the scroll rate, pick chart preference, set slewing rate and customize certain user features. It also allows you to set the type of tracking—altazimuth, equatorial or terrestrial. Use the ENTER, UP and DOWN buttons to change and enter preferences.

The scroll rate ranges from 0, the slowest, to 9, the fastest. The chart can be changed from SA, Wil Tirion's Sky Atlas 2000.0, to UA, the Uranometria catalog.

Here is a list of the sub-menus in the SETUP menu.

- SPEED
- TRACK
- RATE
- PEC
- VOLTS
- AZM GEAR
- ALT GEAR
- AZM BACK
- ALT BACK
- CORD
- BTN SPD
- BTN SLEW
- CHART
- SCROLL
- VERSION

Here is a description of each SETUP item.

### ***SPEED***

This allows you to adjust the speed the telescope is driven by the diamond buttons. The Ultima 2000 has five speed settings:

|          |   |
|----------|---|
| SLEW     | 10 degrees per second, or faster. This depends on the power source. |
| FINDER   | 2 degrees per second.   |
| CENTER   | 6 x sidereal rate   |
| 2 X SDRL | 2 x sidereal rate   |
| PHOTO    | .5 x sidereal rate  |

Here is how to change the SPEED setting.

| <b><u>ACTION</u></b>        | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b> |
|-----------------------------|---|-----------------------|
| Start off at the SETUP menu |   | MENU<br>SETUP         |
| press ENTER                 | The telescope comes from the factory set so the speed should be at CENTER. Otherwise the speed will remain at its last setting. | SPEED<br>CENTER       |
| press ENTER                 | Enter into the SPEED selection list.  | SPEED<br>CENTER       |
| press DOWN                  | Scroll to the next SPEED setting.   | SPEED<br>2 X SDRL     |

|            |                                   |                 |
|------------|-----------------------------------|-----------------|
| press DOWN | Scroll to the next SPEED setting. | SPEED<br>PHOTO  |
| press DOWN | Scroll to the next SPEED setting. | SPEED<br>FINDER |

You may have noticed that you cannot get to the SLEW rate. This is because the SLEW option is disabled at the factory. It is disabled as a safety feature. It is possible to slew the telescope into your head because you thought you were in a different speed rate.

There are two ways to SLEW the telescope.

- One is set the speed to FINDER rate, hold down the diamond button for the direction you want to slew, then press the opposite diamond button simultaneously. The telescope will SLEW.
- The second way is to disable the safety, which we do not recommend for normal use. If there are circumstances that require this, see the section on "SETUP-BTN SLEW".

Here is another method for changing speeds, but be sure the BTN SPD is set to ON. See the description of BTN SPD, later on in this section.

| ACTION  | NOTES   | DISPLAY         |
|---|---|-----------------|
| Start anywhere  | You can be in the main menu or any sub menu and this method will work. Just be sure the BTN SPD is set to ON or this will not work. For an example we will be at the TIMER menu | MENU<br>TIMER   |
| hold down the right DIAMOND button                    | The screen changes to the SPEED screen with the speed setting blinking. Let's say it was last set to CENTER, so the "C" is blinking.  | SPEED<br>CENTER |
| while still holding the DIAMOND button, press UP once | The SPEED selection changes to...   | SPEED<br>FINDER |

You can change to any of the speeds this way except for SLEW. Again for SLEW, you need to leave the telescope in FINDER speed and use one of the techniques described above.

## TRACK

There are four tracking rate settings:

- OFF
- ALT AZ
- EQ SOUTH
- EQ NORTH

The OFF setting is useful when aligning the telescope to the stars or when the telescope is being used terrestrially.

The most common use of the Ultima 2000 is in ALT-AZ mode. In this setting, the telescope will track the stars in the altazimuth configuration. Just put the telescope on the tripod, align it to two stars and you are ready to go.

EQ NORTH and EQ SOUTH are for polar aligned scopes using the optional wedge. This makes the RA tracking motors run at sidereal rate. The DEC motors do not run unless you are running them manually.

## RATE

The Ultima 2000 has four tracking rates for tracking the objects in the sky. Here is what each is for:

SIDEREAL      Use this rate for tracking the stars.

|       |  |
|-------|--|
| KING  | Use this rate for tracking stars low on the horizon. Due to atmospheric refraction, stars and objects near the horizon travel at a slightly slower rate. |
| SOLAR | This rate is used for tracking the Sun.  |
| LUNAR | This rate is used for tracking the Moon.   |

## ***PEC***

This is only used on a telescope that is polar aligned on a wedge. Furthermore, you need to have the tracking rate set to EQ NORTH or EQ SOUTH.

Periodic error correction, or PEC, is used for astrophotography or CCD work. PEC corrects for repeating errors caused by the worm gear. The worm takes about 5.4 minutes to make one complete revolution. Any errors in the worm will repeat every time the worm makes a revolution. These are called periodic errors. These errors can be corrected by using the PEC TRAIN function.

Watch a star with an illuminated reticle eyepiece, like the Celestron Micro Guide Eyepiece. You will notice that the star will slowly drift ahead or behind the illuminated crosshairs. Using the diamond buttons, set to PHOTO speed, practice keeping the star centered. Set PEC to TRAIN. Keep the star centered using the diamond buttons. The PEC is remembering the corrections you make. After 5.4 minutes, it will play back the corrections you made and still keep recording any new corrections. When you feel it is tracking well, switch PEC to ON. Now, the PEC will play back the corrections and will not record any new corrections you make. Any resulting tracking errors are random in nature and must be corrected manually.

## ***VOLTS***

This is a built-in voltmeter to give you an idea of the status of your batteries. 8.5 volts is about the minimum the telescope needs to run. The maximum voltage is about 18 Volts. Any higher voltage is not recommended and can significantly shorten the life of the SLEW motors.

## ***AZM GEAR***

The Azimuth Gear Ratio: This allows you to change the relative speed of the tracking motors. This can be useful for tracking comets or asteroids. The factory setting is 1.0000. The range of settings is from 0.0000 to 2.9999. When set to 0.0000, the motors will not drive at all, and when set to 2.9999, the motors will run almost 3 times faster. The relationship of drive speed to this number is linear. 1.5000 will run the motors at 1.5X.

Here is how to change the gear ratio.

| <b><u>ACTION</u></b> | <b><u>NOTES</u></b>  | <b><u>DISPLAY</u></b> |
|----------------------|--|-----------------------|
| Start at SETUP menu  | If you want to do this under the sky you will be able to see the effects in an eyepiece. Be sure tracking is ON and the telescope is star aligned. | MENU<br>SETUP         |
| press ENTER          | Enter into the list of SETUP items.  | SPEED<br>CENTER       |
| press DOWN 5 times   | Scroll down to the AZM GEAR item   | AZM GEAR<br>1.0000    |
| press ENTER          | Enter into the AZM GEAR menu. The leading "1" will now blink.  | AZM GEAR<br>1.0000    |
| press DOWN           | Changes the one to zero. The tracking rate is now zero.  | AZM GEAR<br>0.0000    |

|                  |  |                    |
|------------------|--|--------------------|
| press ENTER      | Accept the entry of zero and move the cursor to the next character.                  | AZM GEAR<br>0.0000 |
| press UP 5 times | Change tracking speed to 1/2 normal speed  | AZM GEAR<br>0.5000 |
| press MENU       | Return to main menu. The new AZM GEAR ratio will remain .5 even after cycling power. | MENU<br>SETUP      |

## ***ALT GEAR***

Altitude Gear Ratio: This works the same as AZM GEAR.

## ***AZM BACK - Azimuth Backlash Compensation***

There is an enormous gear reduction between the tracking motor and the telescope. Highly accurate tracking is best obtained by running the tracking motor at a relatively high speed. (If an electric motor is run too slowly, it runs at an inconsistent speed, and can burn the brushes.) The high speed of the tracking motor requires a very large gear ratio, on the order of 600,000 to 1. When the tracking motor changes direction, there is a slight delay before movement is visible in the field of view due to the high gear ratio. This phenomenon is referred to as backlash. The Ultima 2000 automatically compensates for backlash, and this compensation is settable. The displayed number is the specified width of the backlash deadzone (the time where the telescope is motionless) in eighths of a tracking motor revolution.

The backlash compensation is preset at the factory to zero. When the telescope is equatorially mounted (on a wedge), the azimuth backlash does not matter. So the AZM BACK value can remain set at zero. The azimuth compensation is only needed for Alt-Az tracking and for most people, it still won't be needed. To change the setting see the next section, "ALT BACK".

## ***ALT BACK***

For astrophotography or CCD imaging, the altitude backlash compensation is critical. The azimuth compensation is only needed for Alt-Az tracking.

It is easiest to set the backlash compensation in the daytime on a distant object with a high power eyepiece. For step-by-step instructions on how to determine the backlash compensation, see the chapter called Procedures. Here is how to set the altitude backlash compensation value on the hand control.

| <b><u>ACTION</u></b>                             | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b> |
|--|---|-----------------------|
| <b>Example: Set the ALT BACK to 400 from 340</b> |   |                       |
| Go to the SETUP menu                             |   | MENU<br>SETUP         |
| Press ENTER<br>Set SPEED to 2 X SDRL             | Enter into the SETUP menu and change the SPEED setting.         | SPEED<br>2 X SDRL     |
| Press DOWN 7 times<br>and note the setting       | Scroll down to the ALT BACK mode.                               | ALT BACK<br>00340     |
| Press ENTER                                      | The cursor is at the first digit of the azimuth backlash value. | ALT BACK<br>00340     |
| Press ENTER twice                                | Place the cursor at the leading number.                         | ALT BACK<br>00340     |
| Press UP   | Change the 3 to a 4.  | ALT BACK<br>00440     |
| Press ENTER                                      | Move the cursor to the next digit to the right.                 | ALT BACK<br>00440     |
| Press DOWN 4 times                               | Set the 4 to 0.   | ALT BACK<br>00400     |

|                     |                                 |                   |
|---------------------|---------------------------------|-------------------|
| Press ENTER 2 times | The compensation is set to 400. | ALT BACK<br>00400 |
| Press MENU          | Return to the main menu.        | MENU<br>SETUP     |

For more information see the section “Determining the Altitude Backlash Compensation” in Chapter 8.

### ***CORD - Cord Wrap Control***

This is the cord wrap mode. This keeps the telescope from wrapping the cord around itself. The mode can be ON or OFF. It is useful to turn this OFF if you are not using an external power source and desire the telescope to slew through the shortest distance to the object.

To turn cord wrap ON and OFF:

| <b><u>ACTION</u></b> | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b> |
|----------------------|---|-----------------------|
| Start at SETUP menu  |   | MENU<br>SETUP         |
| press ENTER          | Enter into the list of SETUP items.   | SPEED<br>CENTER       |
| press UP 6 times     | ( <i>For changing BTN SPD, press UP 5 times</i> )<br>( <i>For changing BTN SLEW, press UP 4 times</i> ) | CORD<br>ON            |
| press ENTER          |   | CORD<br>ON            |
| press UP             | Turn the Cord Wrap mode OFF.  | CORD<br>OFF           |
| press UP             | Turn the Cord Wrap mode ON  | CORD<br>ON            |
| press MENU           | Return to main menu   | MENU<br>SETUP         |

### ***BTN SPD - Button Speed***

This function, when turned ON, displays the SPEED menu whenever a diamond button is pressed. When the button is released, the display returns to its original screen. The advantage is, you can change the SPEED just by holding down a diamond button and then using the UP or DOWN buttons to scroll through the different speeds.

There are times you might want this function turned off. When you are looking at the RA and DEC of the telescope under the POSITION menu, you might not want the screen to change when you press a diamond button.

Turning BTN SPEED ON and OFF is exactly the same as turning cord wrap ON and OFF (the previous example). The only difference is on the third step, press the UP button 5 times instead of 6 times.

### ***BTN SLEW - Button Slew***

This is a safety mode for slewing. When this is turned OFF (as it comes from the factory), the SLEW setting cannot be activated. The only way to activate SLEW speed is described in the SPEED section of this Chapter. When BTN SLEW is set to ON, then SLEW can be activated like any of the other speeds.

Turning BTN SLEW ON and OFF is exactly the same as turning cord wrap ON and OFF. The only difference is on the third step, press the UP button 4 times instead of 6 times. This places you at the BTN SLEW option.

## **CHART**

This menu allows you to select the type of star atlas the Ultima 2000 is using. The two atlas choices are Uranometria or W. Tirion's Sky Atlas 2000. These are represented in the Ultima 2000 by UA and SA respectively. In CONSTELL menu under POSITION, the displayed atlas page is keyed to the selected atlas.

## **SCROLL**

This mode sets the speed at which information is scrolled across the screen. The range goes from 1 to 9, slowest to fastest.

## **VERSION**

This tells the version of the software that is installed in the telescope. The display shows eight digits. The first four digits show the version of the Hand Control software while the last four digits show the version of the telescope software.

## **Menu TOUR**

---

This menu item has a list of interesting objects for each month of the year. In this mode, you choose either DEMO or MANUAL. Then, you choose a month of the year. If you choose DEMO, the telescope automatically slews to each of the objects on the list, pausing about 20 seconds at each object. This is useful for watching the scope move indoors for demonstration purposes. This is not useful for observing because the telescope slews without any warning.

In MANUAL, the telescope does not initiate slew operations until you tell it to. The UP and DOWN buttons let you skip forward in the list or backwards in the list. The down button is forward, as in reading down a list. Pressing the ENTER button once, you get a scrolling message with information about the object. While the message is scrolling in the bottom part of the display, the top part of the display reads GO TO with the "G" blinking. If you press ENTER while the display says GO TO, the telescope will slew to the object. If you wait for the message to finish, the display will give the name of the object and give directional arrows that will guide you to the object.

Here is an example of each.

### **DEMO mode indoors**

1. Place the telescope to its downstops.
2. Turn the telescope ON.
3. Press the UP button to scroll to the TOUR menu.
4. Press ENTER and ignore the "STAR ALIGNMENT REQUIRED" message.
5. The display will read, "TOUR JAN". Since you are not really looking at the star, the month does not matter.
6. Press ENTER. The telescope will start slewing.
7. To stop the telescope from slewing to objects, press the MENU.

Note: Continuous slewing will greatly decrease the life of the batteries. It is advisable to use an external power source when using the TOUR option for any length of time. If you are using an external power source, be sure that the Cord Wrap mode is enabled. Do this in the SETUP menu under the CORD sub-menu.

## **MANUAL mode under the sky**

Set up the telescope outside and align it to the night sky. Here is how to activate the tour option.

| ACTION  | NOTES  | DISPLAY                    |
|---|--|----------------------------|
| Start at the TOUR menu                                      |  | MENU<br>TOUR               |
| Press ENTER   | Enter into the TOUR menu.  | DEMO                       |
| Press DOWN - to the MANUAL option                           | Choose the MANUAL option.  | MANUAL                     |
| Press ENTER   | Enter into MANUAL.   | TOUR JAN                   |
| Use the UP/DOWN buttons to scroll to the appropriate month. | For example, use July.   | TOUR JUL                   |
| Press ENTER   | The first object to come up in July is M92. It will be different for you depending on the month you picked.    | 57 ← 94 ↑<br><b>M 092</b>  |
| Press ENTER   | Message scrolls and the display changes to the GO TO menu. It stays at the GO TO menu until the display stops. | GO TO<br>Message Scrolls   |
| Press ENTER while GO TO is still displayed                  | The telescope slews to the object.   | GO TO<br>SLEWING           |
| NA  | At the end of the slew the display reads.  | 0°0 0°0<br><b>M 092</b>    |
| Press DOWN  | Scroll to the next Tour object.  | 83 → 129 ↑<br><b>M 013</b> |
| Press Enter twice   | Activate the GO TO function.   | GO TO<br>SLEWING           |

---

## **Brightness Setting**

The brightness of the display can be varied by pressing the BRIGHTNESS button, which is above and to the right of the readout. The hand control has five settings. The lowest setting is bright enough for night time use. Using the lowest setting will increase battery life.

---

## **Slewing Speed Setting**

You may change the slewing and positioning speed of your Ultima 2000. There are 5 different settings:

- SLEW                    10 degrees per second High Speed Slewing, default setting. (Not shown on the display unless BTN SLEW is turned to ON under the SETUP menu.)
- FINDER                2 degrees per second Slow Speed Slewing, used for fine positioning.
- CENTER               6 times sidereal Rate Speed used for centering an object in the eyepiece.
- 2 X SDRL             2 times sidereal Rate Guide speed, used for fine centering or astrophotography.
- PHOTO                .5 times sidereal Rate Fine guide speed, used for Astrophotography.

To change the slewing rate, go to the SPEED sub-menu under the SETUP menu. When you press ENTER at the SPEED sub-menu, the first letter of the current speed rate will blink. Use the UP/DOWN buttons to change the current setting.

The SLEW setting might not appear as one of the choices. This depends on the SLEW SPEED sub-menu (under SETUP) being set ON or OFF. To make the SLEW option available within the SPEED menu, set SLEW SPEED to ON.

**WARNING:** It is advisable to leave SLEW SPEED set to OFF. The telescope slews quickly and could possibly hit you in the eye if you forget that you have the setting at the slew rate.

Another way to move the telescope at the SLEW rate is to set SPEED to FINDER. If you press the diamond button that corresponds to the direction you want the telescope to slew, then simultaneously press the opposite diamond button, the telescope will move at the SLEW rate. This same procedure works with PHOTO and 2XSDRL speeds; the telescope will jump up to CENTER speed when the buttons are pressed simultaneously.

---

## DRIVE BASE

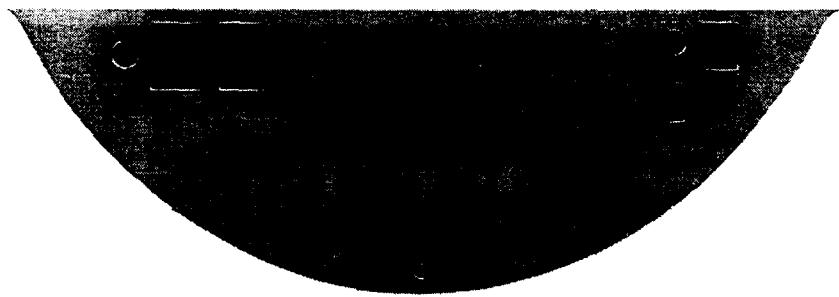


Figure 4-2: The Drive base cover of the Ultima 2000

Here are the functions of the different drive base controls and interfaces.

| LABEL  | PURPOSE  |
|--------|--|
| FOCUS  | This jack is for the optional focus motor, #94143. To use the focus motor, hold down the MENU button then press the UP or the DOWN button while still holding down the MENU button. The UP button turns the focus knob counter-clockwise.  |
| AUX    | This jack is for a CCD Auto Guider.  |
| HC     | Hand controller plug-in jack.  |
| ON/OFF | On/Off power switch.   |
| EER    | Enhanced Encoder Resolution. When the light is blinking about once a second, the standard resolution is operational. When the light blinks about twice a second, then one of the axes is in enhanced resolution. When the light stays on, then both of the axes are in enhanced encoder resolution. The way to activate EER on any one of the axes is to run the motor at CENTER speed in one direction for a few seconds until the light blinking changes. When centering on an alignment star, it is best to move the telescope with the tracking motors (at center speed) until the star is centered. This should activate the EER and give you a better alignment. |
| 12V    | Used to run off of an external source like a car battery or a wall transformer - AC Adapter (12V 500mA center tip positive).   |



## The Schmidt-Cassegrain System

A telescope is an instrument that collects and focuses light. The nature of the optical design determines how the light is focused. Some telescopes, known as refractors, use lenses. Other telescopes, known as reflectors, use mirrors. The Schmidt-Cassegrain optical system (or Schmidt-Cass for short) uses a combination of mirrors and lenses and is referred to as a compound or catadioptric telescope. This unique design offers large-diameter optics while maintaining very short tube lengths, making them extremely portable. The Schmidt-Cassegrain system consists of a zero power corrector plate, a spherical primary mirror, and a secondary mirror. Once light rays enter the optical system, they travel the length of the optical tube three times.

The optics of the Ultima 2000 has Starbright coatings - an enhanced multi-layer coating on the primary and secondary mirrors for increased reflectivity and a fully coated corrector for the finest anti-reflection characteristics.

Inside the optical tube a black tube (not illustrated) extends out from the center hole in the primary mirror. This is the primary baffle tube and it prevents stray light from passing through to the eyepiece or camera.

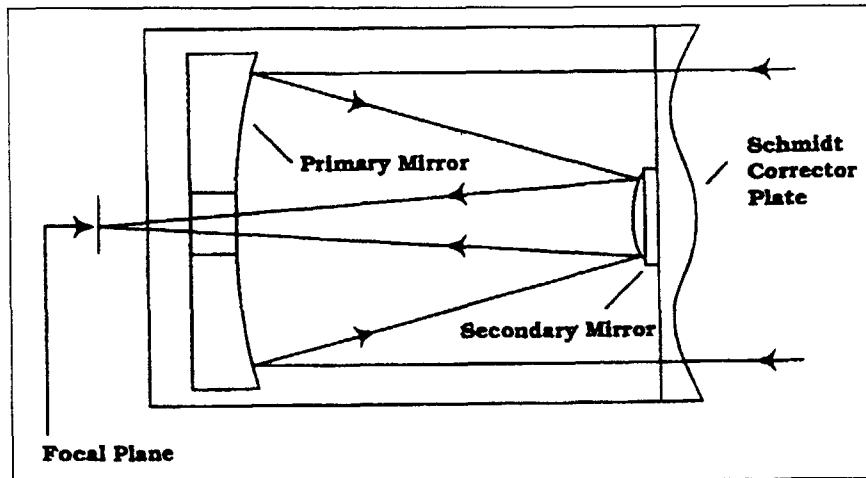
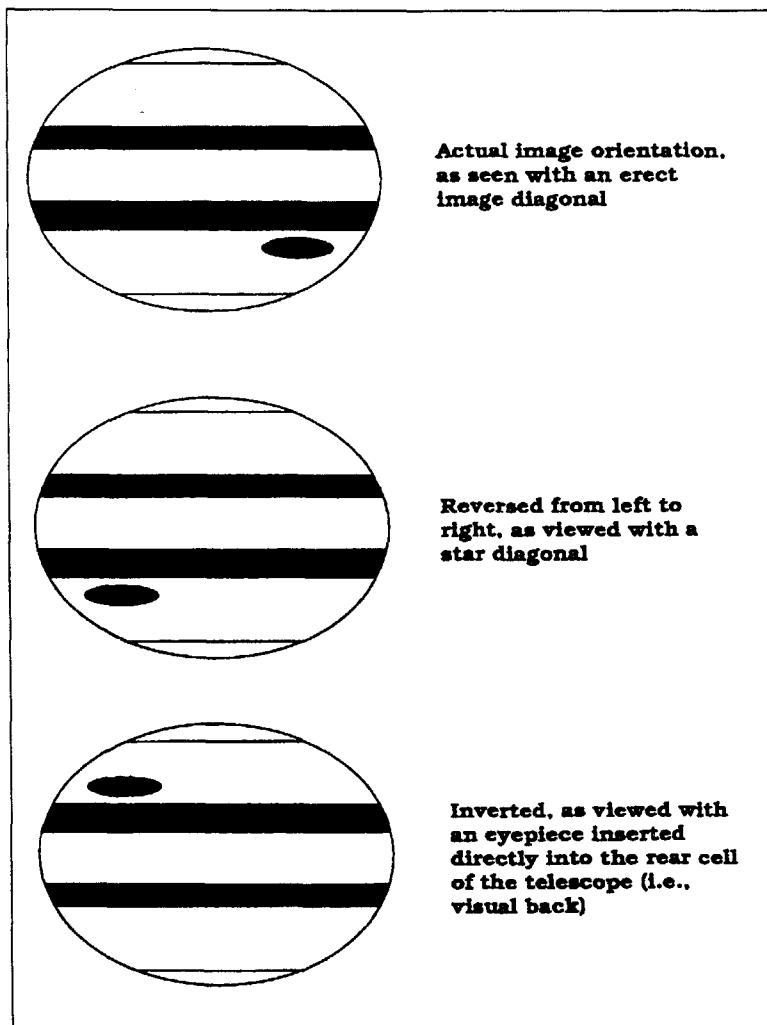


Figure 5-1

This cross-sectional diagram shows the light path of the Schmidt-Cassegrain optical system. Note that the light rays travel the length of the telescope tube three times, making this a compact optical design. Note that the curve of the corrector plate is greatly exaggerated.

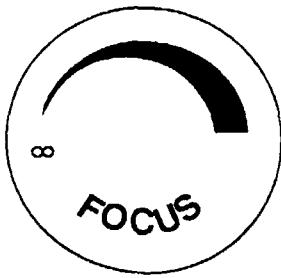
## Image Orientation

It should be noted that the image orientation will change depending on the viewing configuration. When using the star diagonal, the image is right-side-up, but reversed from left-to-right. If inserting the eyepiece into the visual back (i.e., without the star diagonal), the image is inverted (upside down and reversed from left-to-right). This holds true for the 7x50 finder as well as the telescope. For correct orientation through the telescope, which is important primarily for terrestrial observing, use the optional 45° erect image diagonal (#94112-A) or the 90° model (#94108).



**Figure 5-2**

These simplified drawings of the planet Jupiter illustrate the different image orientations obtained when using various viewing configurations.

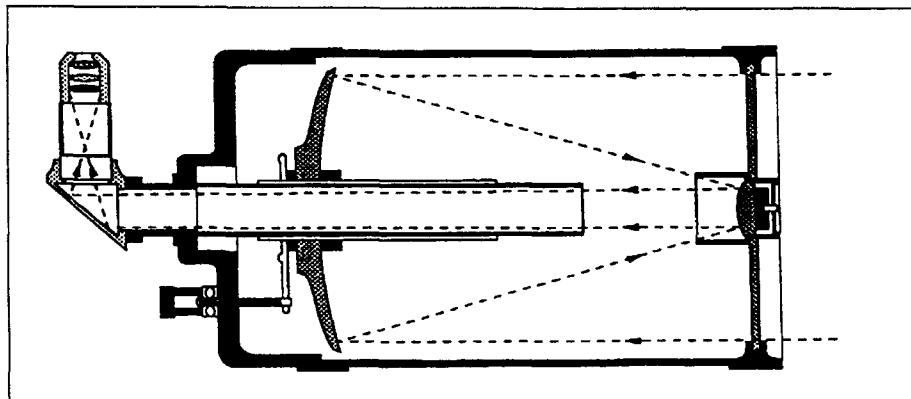


**Figure 5-3**  
The decal on the end of the focus knob shows the correct rotational direction for focusing your telescope.

The primary mirror is mounted on a ring which slides back and forth on the primary baffle tube (see Figure 4-4). The focusing knob, which moves the primary mirror, is on the rear cell of the telescope. To focus, turn the focusing knob until the image is sharp. If the knob will not turn, it has reached the end of its travel on the focusing mechanism. Turn the knob in the opposite direction until the image is sharp. Once an image is in focus, turn the knob clockwise to focus on a closer object and counterclockwise for a more distant object. A single turn of the focusing knob moves the primary mirror only slightly. Therefore, it will take many turns (about 40) to go from close focus (approximately 25 feet) to infinity.

For astronomical viewing, out of focus star images are very diffuse making them difficult, if not impossible, to see. If you turn the focus knob too quickly, you can go right through focus without seeing the image. To avoid this problem, your first astronomical target should be a bright object (like the Moon or a planet) so that the image is visible even when out of focus.

Critical focusing is best accomplished when the focusing knob is turned in such a manner that the mirror moves against the pull of gravity. In doing so, any mirror shift is minimized. For astronomical usage, both visually and photographically, this is done by turning the focus knob counterclockwise.



**Figure 5-4** This diagram shows the focusing mechanism

## Your First Look

With the telescope fully assembled and all the accessories attached you are ready for your first look. Your first look should be done in the daytime.

## **Daytime Observing**

---

Your Celestron telescope works well as a terrestrial spotting scope. When not used to examine objects in the night sky, it can be used to study objects here on Earth.

**WARNING ! NEVER POINT YOUR TELESCOPE AT THE SUN UNLESS YOU HAVE THE PROPER SOLAR FILTER. PERMANENT AND IRREVERSIBLE EYE DAMAGE MAY RESULT AS WELL AS DAMAGE TO YOUR TELESCOPE. ALSO, NEVER LEAVE YOUR TELESCOPE UNATTENDED DURING A DAYTIME OBSERVING SESSION, ESPECIALLY WHEN CHILDREN ARE PRESENT.**

1. Begin by finding a distant object that is fairly bright.
2. Insert a low power eyepiece (one with a large focal length) into the telescope. The standard 26mm eyepiece is fine.
3. Point the telescope in the general direction of the object you selected.
4. Locate the object in your finderscope.
5. Center the object in the field of the finderscope by using the hand control buttons or moving the tube manually very slowly.
6. Once centered, look through the main optics and the object will be there (if you aligned the finder first).

Try using different optional eyepieces to see how the field changes with various magnifications. Casual terrestrial observing can be done with the telescope and fork mount placed on a flat, sturdy surface.

---

## **Calculating Magnification**

You can change the power of your telescope just by changing the eyepiece (ocular). To determine the magnification for the Ultima 2000 - 8", you would simply divide the focal length of the telescope (2032mm) by the focal length of the eyepiece that you are using. In equation format, the formula looks like this:

$$\text{Magnification} = \frac{\text{Focal Length of Telescope (mm)}}{\text{Focal Length of Eyepiece (mm)}}$$

Let's say, for example, that you are using a 10mm eyepiece. To determine the magnification, simply divide the focal length of your 8" (2032mm) by the focal length of the eyepiece (10mm). Dividing 2032 by 10 yields a magnification of 203 power.

Although the power is variable, each instrument has a limit to the highest useful magnification. The general rule is that 60 power can be used for every inch of aperture. For example, the Ultima 2000-8" is 8" in diameter. Multiplying 8 by 60 gives a maximum useful magnification of 480 power. Although this is the maximum useful magnification, most observing is done in the range of 20 to 35 power for every inch of aperture which is 160 to 280 power for the 8".

---

## **Determining Field of View**

Determining the field of view is important if you want to get an idea of the size of the object you are observing. To calculate the actual field of view, divide the apparent field of the eyepiece (supplied by the eyepiece manufacturer) by the magnification. In equation format, the formula looks like this:

$$\text{True Field} = \frac{\text{Apparent Field of Eyepiece (in degrees)}}{\text{Magnification}}$$

Using the example we started with above, we can determine the field of view using the same 10mm eyepiece. The 10mm eyepiece has an apparent field of view of 46°. Divide the 46° by the magnification, which is 200 power. This yields an actual field of .2°, or a little less than a quarter of a degree.

For terrestrial viewing, field size is often referred to as feet at a thousand yards. To convert this to feet at one thousand yards, multiply the actual field of .2° by 52.5. This produces a field width of 10.5 feet at one thousand yards.

The apparent field of each eyepiece that Celestron manufacturers is found in the Celestron Accessory Catalog (#93685).

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## General Observing Hints

When working with any optical instrument, there are a few things to remember to ensure you get the best possible image.

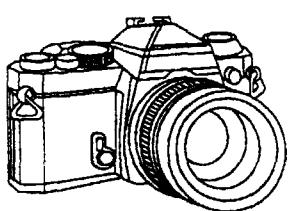
- Never look through window glass. Glass found in household windows is optically imperfect and, as a result, may vary in thickness from one part of a window to the next. This inconsistency can and will affect the ability to focus your telescope. In most cases you will not be able to achieve a truly sharp image. In some cases, you may actually see a double image.
- Never look across or over objects that are producing heat waves. This includes asphalt parking lots on hot summer days or building rooftops.
- Hazy skies, fog, and mist can also make it difficult to focus when viewing terrestrially. The amount of detail seen under these conditions is greatly reduced. Also, when photographing under these conditions, the processed film may come out a little grainier than normal with lower contrast.
- When using your telescope as a telephoto lens, the split screen or micropism focuser of the 35mm SLR camera may "black out." This is common with all long focal length lenses. If this happens, use the ground glass portion of your focusing screen. To achieve a very sharp focus, consider using a focusing magnifier. These are readily available from your local camera store.
- If you wear corrective lenses (specifically eyeglasses), you may want to remove them when observing with an eyepiece attached to your telescope. When using a camera, however, you should always wear corrective lenses to ensure the sharpest possible focus. If you have astigmatism, corrective lenses should be worn at all times.

---

## General Photography Hints

Your Ultima 2000 can be used for both terrestrial and astronomical photography. It has a fixed aperture and, as a result, a fixed f/ratio. To properly expose your subjects photographically, you need to set your shutter speed accordingly. Most 35mm single lens reflex (SLR) cameras offer through-the-lens metering that lets you know if your picture is under or overexposed. This is important for terrestrial photography where exposure times are measured in fractions of a second.

In astrophotography, the exposures are much longer, requiring that you use the "B" setting on your camera. The actual exposure time is determined by how long you keep the shutter open. More on this in the section on "Celestial Photography."



To reduce vibration when tripping the shutter, use a cable release. Releasing the shutter manually can cause vibration, something that produces blurred photos. A cable release allows you to keep your hands clear of the camera and telescope, thus reducing the possibility of shaking the telescope. Mechanical shutter releases can be used, though air type releases are best.

This section deals with observational astronomy in general. It includes information on the night sky, polar alignment and using your telescope.

## The Celestial Coordinate System

To help find objects in the sky, astronomers use a celestial coordinate system that is similar to our geographical coordinate system here on Earth. The celestial coordinate system has poles, lines of longitude and latitude, and an equator. For the most part, these remain fixed against the background stars.

The celestial equator runs 360 degrees around the Earth and separates the northern celestial hemisphere from the southern. Like the Earth's equator, it bears a reading of zero degrees. On Earth this would be latitude. However, in the sky this is referred to as declination, or DEC for short. Lines of declination are named for their angular distance above and below the celestial equator. The lines are broken down into degrees, minutes of arc, and seconds of arc. Declination readings south of the equator carry a minus sign (-) in front of the coordinate and those north of the celestial equator are either blank (i.e., no designation) or preceded by a plus sign (+).

The celestial equivalent of longitude is called Right Ascension, or R.A. for short. Like the Earth's lines of longitude, they run from pole to pole and are evenly spaced 15 degrees apart. Although the longitude lines are separated by an angular distance, they are also a measure of time. Each line of longitude is one hour apart from the next. Since the Earth rotates once every 24 hours, there are 24 lines total. As a result, the R.A. coordinates are marked off in units of time. It begins with an arbitrary point in the constellation of Pisces designated as 0 hours, 0 minutes, 0 seconds. All other points are designated by how far (i.e., how long) they lag behind this coordinate after it passes overhead moving toward the West.

Your Ultima 2000 telescope is computer driven which translates the celestial coordinates into a precise location for the telescope to point.

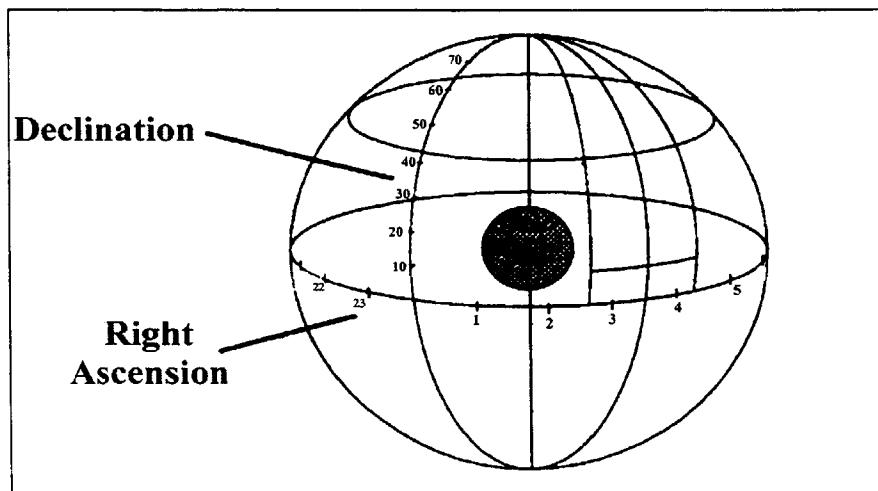
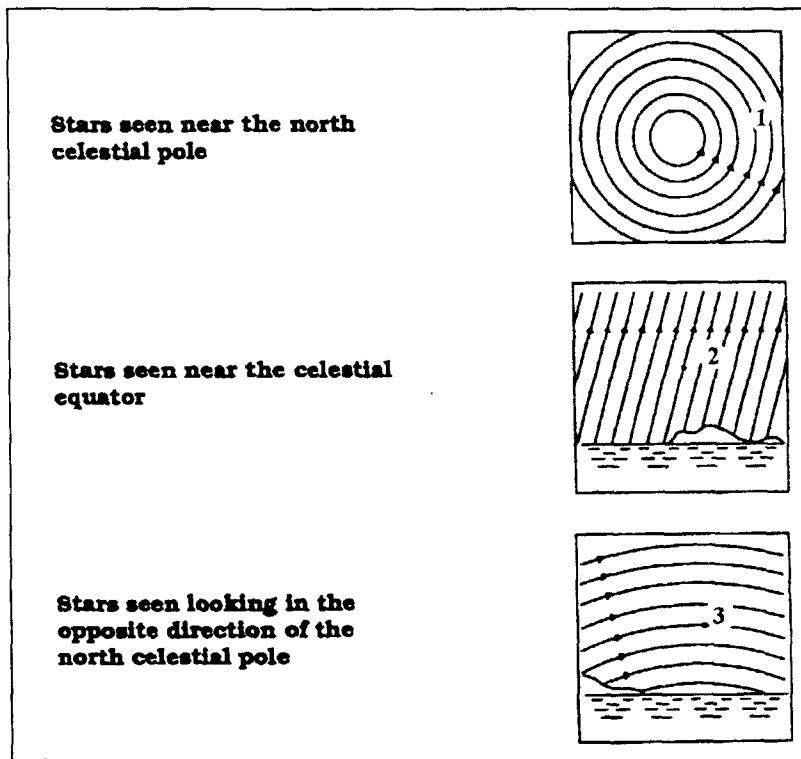


Figure 6-1

The celestial sphere seen from the outside showing R.A. and DEC.

## Motion of the Stars

Like the Sun, the stars also appear to move across the sky. This motion is caused by the Earth's rotation. For observers in the northern hemisphere, all stars appear to move around the north celestial pole. For observers in the southern hemisphere, all stars appear to move around the south celestial pole. This means that over a 24-hour period, any given star will scribe out a complete circle around its respective celestial pole. The farther you move away from the celestial pole, the larger this circle becomes and is largest at the celestial equator. Stars near the celestial equator rise in the east and set in the west. However, stars near the celestial poles are always above the horizon. They are said to be circumpolar because they don't rise and set. You will never see the stars complete one circle because the sunlight during the day washes out the starlight. However, part of this circular motion of stars in this region of the sky can be seen by setting up a camera on a tripod and opening the shutter for a couple of hours. The processed film will reveal circular arcs that are centered on the pole. This information will be useful for certain methods of polar alignment.



**Figure 6-2** All stars appear to rotate around the celestial poles. However, the appearance of this motion varies depending on where you are looking in the sky. Near the north celestial pole the stars scribe out recognizable circles centered on the pole (1). Stars near the celestial equator also follow circular paths around the pole. But, the complete path is interrupted by the horizon. These appear to rise in the East and set in the West (2). Looking toward the opposite pole, stars curve or arc in the opposite direction scribing a circle around the opposite pole (3).

## Polar Alignment (with Wedge)

In order to do astrophotography, your Ultima 2000 requires an optional equatorial wedge. Ultima 2000's have built-in drive motors designed specifically for tracking. Then you need to set the telescope's axis of rotation so that it tracks in the right direction. Since the motion of the stars across the sky is caused by the Earth's rotation about its axis, the telescope's axis must be made parallel to the Earth's.

Polar alignment is the process by which the telescope's axis of rotation (called the polar axis) is aligned (made parallel) with the Earth's axis of rotation. Once aligned, a telescope with a clock drive will track the stars as they move across the sky. The result is that objects observed through the telescope appear stationary (i.e., they will not drift out of the field of view). If you are not using the clock drive, all objects in the sky (day or night) will slowly drift out of the field. This motion is caused by the Earth's rotation. Since the Ultima 2000 tracks the stars in the Alt-Az configuration, the only time you will need to polar align the telescope is when you are doing astrophotography or CCD imaging. But, for any sort of long exposure astrophotography, you must polar align the telescope on a wedge due to field rotation. There are several methods of polar alignment, all work on a similar principle, but performed somewhat differently. Each method is considered separately, beginning with the easier methods and working to the more difficult.

Although there are several methods mentioned here, you will never use all of them during one particular observing session. Instead, you may use only one if it is a casual observing session. Or, you may use two methods; one for rough alignment followed by a more accurate method.

**Definition:** The polar axis is the axis around which the telescope rotates when moved in right ascension. This axis points the same direction even when the telescope moves in right ascension and declination.

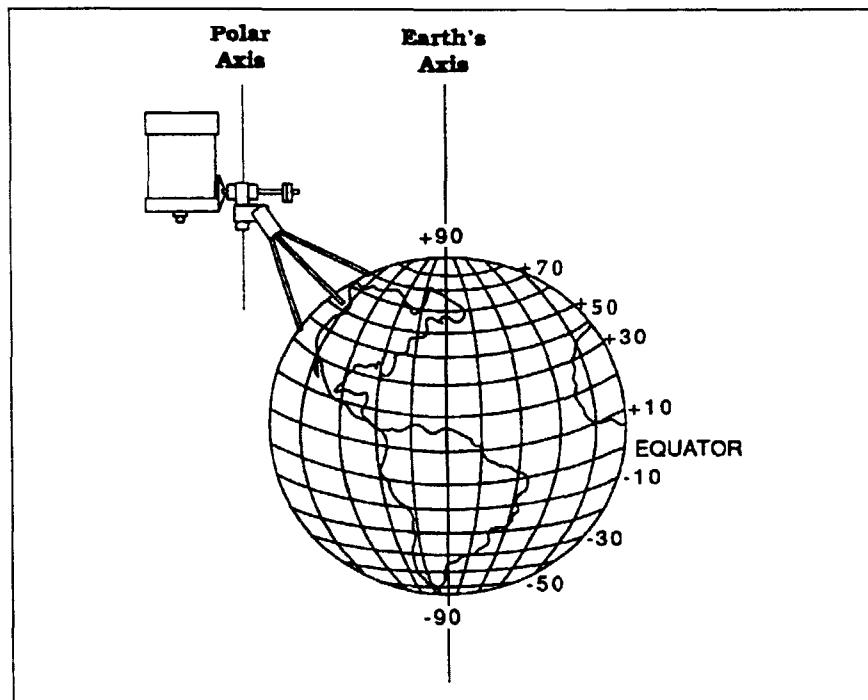
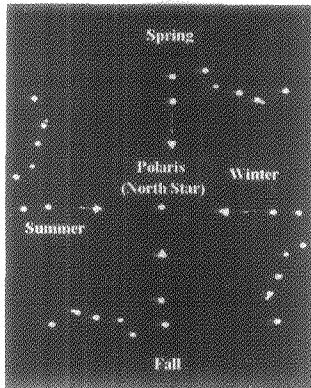


Figure 6-3

## Finding the Pole

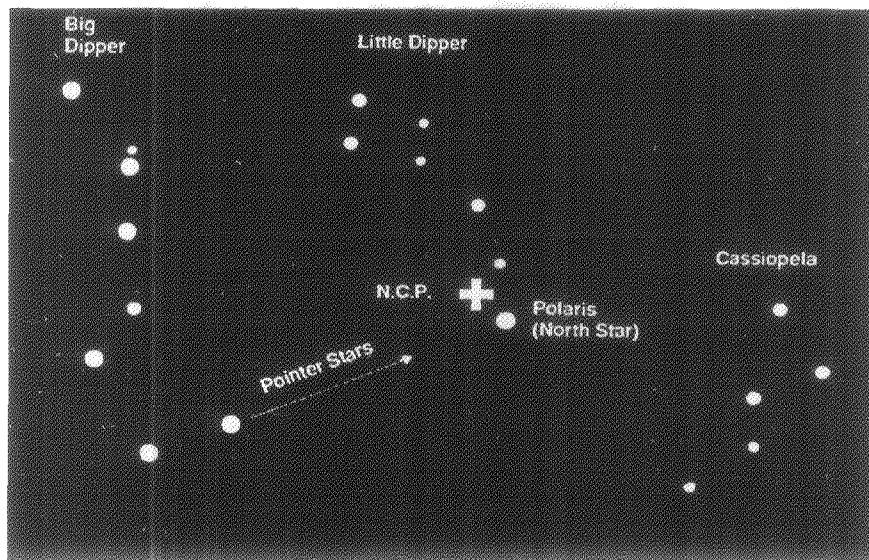
In each hemisphere, there is a point in the sky around which all the other stars appear to rotate. These points are called the celestial poles and are named for the hemisphere in which they reside. For example, in the northern hemisphere all stars move around the north celestial pole. When the telescope's polar axis is pointed at the celestial pole, it is parallel to the Earth's rotational axis.



**Figure 6-4**  
The position of the Big Dipper changes throughout the year and throughout the night.

Many methods of polar alignment require that you know how to find the celestial pole by identifying stars in the area. For those in the northern hemisphere, finding the celestial pole is not too difficult. Fortunately, we have a naked eye star less than a degree away. This star, Polaris, is the end star in the handle of the Little Dipper. Since the Little Dipper (technically called Ursa Minor) is not one of the brightest constellations in the sky, it may be difficult to locate from urban areas. If this is the case, use the two end stars in the bowl of the Big Dipper (the pointer stars). Draw an imaginary line through them toward the Little Dipper. They point to Polaris (see Figure 6-4). The position of the Big Dipper changes during the year and throughout the course of the night (see Figure 6-4). When the Big Dipper is low in the sky (i.e., near the horizon), it may be difficult to locate. During these times, look for Cassiopeia (see Figure 6-5).

Observers in the southern hemisphere are not as fortunate as those in the northern hemisphere. The stars around the south celestial pole are not nearly as bright as those around the North. The closest star that is relatively bright is Sigma Octantis. This star is just within naked eye limit (magnitude 5.5) and lies about 59 arc minutes from the pole. For more information about stars around the south celestial pole, please consult a star atlas.



**Figure 6-5**  
The two stars in the front of the bowl of the Big Dipper point to Polaris which is less than one degree from the true (north) celestial pole. Cassiopeia, the "W" shaped constellation, is on the opposite side of the pole from the Big Dipper. The North Celestial Pole (N.C.P.) is marked by the "+" sign.

## ***Latitude Scales***

---

The easiest way to polar align a telescope is with a latitude scale, which should be located on the wedge. Unlike other methods that require finding the celestial pole by identifying certain stars near it, this method works off of the fact that you know the latitude of the site you are observing from and you know which direction is North.

If you know your latitude, then you know how high the pole is above the Northern Horizon. The angular distance from the northern horizon to the north celestial pole is always equal to your latitude. To illustrate this, imagine that you are standing on the north pole, latitude +90°. The north celestial pole, which has a declination of +90°, would be directly overhead (i.e., 90° above the horizon). Now, let's say that you move one degree south - your latitude is now +89° and the celestial pole is no longer directly overhead. It has moved one degree closer toward the northern horizon. This means the pole is now 89° above the northern horizon. If you move one degree further south, the same thing happens again. As you can see from this example, the distance from the northern horizon to the celestial pole is always equal to your latitude. This relationship between the celestial pole and the horizon also works for the southern hemisphere. However, the angle is then measured from the southern horizon.

If you are observing from Los Angeles, which has a latitude of 34°, then the celestial pole is 34° above the northern horizon. A latitude scale points the polar axis of the telescope at the right elevation above the northern (or southern) horizon.

To align your telescope:

1. Make sure the polar axis of the mount is pointing due north. *Use a landmark that you know faces north. The Polar axis on the Ultima 2000 starts at the base and points up through the forks. If you rotate the forks, they will circle the polar axis of the telescope.* So, point the forks due North.
2. Level the tripod by adjusting the length of the tripod legs. There is a bubble level built into the wedge for this purpose.

**NOTE: Leveling the tripod is only necessary if using this method of polar alignment. Perfect polar alignment is still possible using other methods described later in this manual without leveling the tripod.**

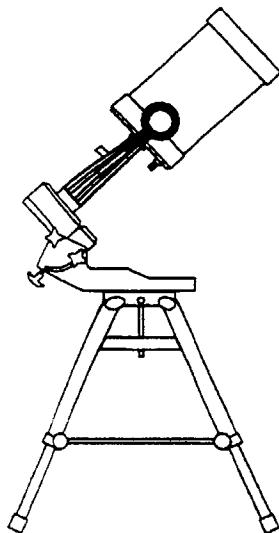
3. Adjust the wedge in altitude until the latitude indicator points to your latitude.

This method can be done in daylight, thus eliminating the need to fumble around in the dark. Although this method does **NOT** put you directly on the pole, it will limit the number of corrections you will make when tracking an object. It is accurate enough for short exposure prime focus planetary photography (a couple of seconds) and short exposure piggyback astrophotography (a couple of minutes).

## **Pointing at Polaris**

This method uses Polaris as a guidepost to the celestial pole. Since Polaris is less than a degree from the celestial pole, you can simply point the polar axis of your telescope at Polaris. Although this is by no means perfect alignment, it does get you within one degree. Unlike the previous method, this must be done in the dark when Polaris is visible.

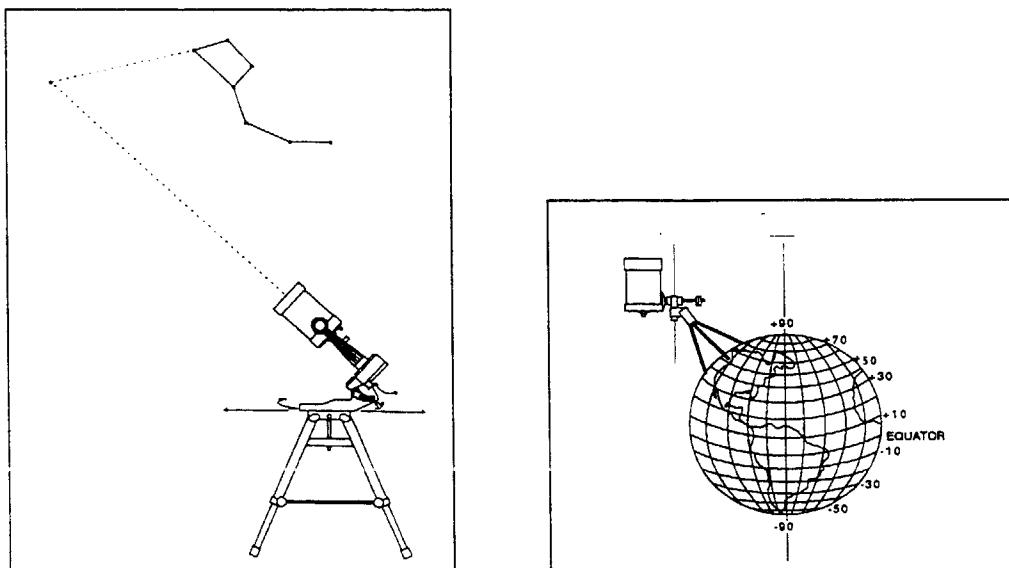
1. Set the telescope up so that the polar axis is pointing north.
2. Move the telescope to its downstop position. Turn the telescope ON.
3. Go to the POSITION menu. Press ENTER and DOWN. The display should read, TELESCOP. Press ENTER. The display reads azimuth on top and altitude on the bottom. The bottom number is the one you are interested in.
4. Move the telescope so that the tube is parallel to the polar axis (see figure 7-6).. When this is done, the bottom number should be very close to  $+90^\circ$ . Get it as close to  $90^\circ$  as possible.
5. Now adjust the wedge in altitude and/or azimuth until Polaris is in the field of view of the finder.
6. Center Polaris in the field of the telescope using the altitude and azimuth adjustment knobs of the wedge.



**Figure 6-6**

**Remember, while polar aligning, do NOT move the telescope. You do not want to move the telescope itself, but the polar axis. The telescope is used simply to see where the polar axis is pointing. You adjust the telescope by moving the wedge and/or tripod.**

Like the previous method, this gets you close to the pole but not directly on it. The following methods help improve your accuracy for more serious observations and photography.



**Figure 6-7**

One might think that pointing at the pole produces a parallax effect, thus skewing the telescope's axis of rotation with that of the Earth's. Polaris, however, is over 50 light years away, thus making any parallax effect negligible. (One light year is 6.4 trillion miles. To find the distance to Polaris in miles, multiply 6.4 trillion by 50!)

## ***Declination Drift***

---

This method of polar alignment allows you to get the most accurate alignment on the celestial pole and is required if you want to do long exposure deep-sky astrophotography through the telescope. The declination drift method requires that you monitor the drift of selected stars. The drift of each star tells you how far away the polar axis is pointing from the true celestial pole and in what direction. Although declination drift is simple and straight-forward, it requires a great deal of time and patience to complete when first attempted. The declination drift method should be done after any one of the previously mentioned methods has been completed.

To perform the declination drift method you need to choose two bright stars. One should be near the eastern horizon and one due south near the meridian. Both stars should be near the celestial equator (i.e., 0° declination). You will monitor the drift of each star one at a time and in declination only. While monitoring a star on the meridian, any misalignment in the east-west direction is revealed. While monitoring a star near the east/west horizon, any misalignment in the north-south direction is revealed. As for hardware, you will need an illuminated reticle ocular to help you recognize any drift. For very close alignment, a Barlow lens is also recommended since it increases the magnification and reveals any drift faster.

When looking due south, insert the diagonal so the eyepiece points straight up. Insert the cross hair ocular and align the cross hairs so that one is parallel to the declination axis and the other is parallel to the right ascension axis. Move your telescope manually in R.A. and DEC to check parallelism.

First, choose your star near where the celestial equator and the meridian meet. The star should be approximately within 1/2 an hour of the meridian and within five degrees of the celestial equator. Center the star in the field of your telescope and monitor the drift in declination.

- If the star drifts south, the polar axis is too far east.
- If the star drifts north, the polar axis is too far west.

Make the appropriate adjustments to the polar axis to eliminate any drift. Once you have eliminated most of the drift, move to the star near the eastern horizon. The star should be 20 degrees above the horizon and within five degrees of the celestial equator.

- If the star drifts south, the polar axis is too low.
- If the star drifts north, the polar axis is too high.

Again, make the appropriate adjustments to the polar axis to eliminate any drift. Unfortunately, the latter adjustments interact with the prior adjustments ever so slightly. So, repeat the process again to improve the accuracy checking both axes for minimal drift. Once the drift has been eliminated, the telescope is very accurately aligned. You can now do prime focus deep-sky astrophotography for long periods.

NOTE: If the eastern horizon is blocked, you may choose a star near the western horizon, but you must reverse the polar high/low error directions. Also, if using this method in the southern hemisphere, the direction of drift is reversed for both R.A. and DEC.

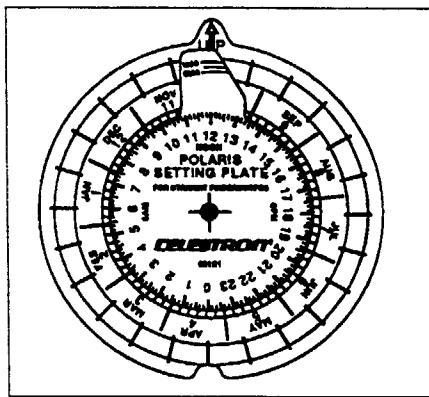
## ***The 7x50mm Finder***

---

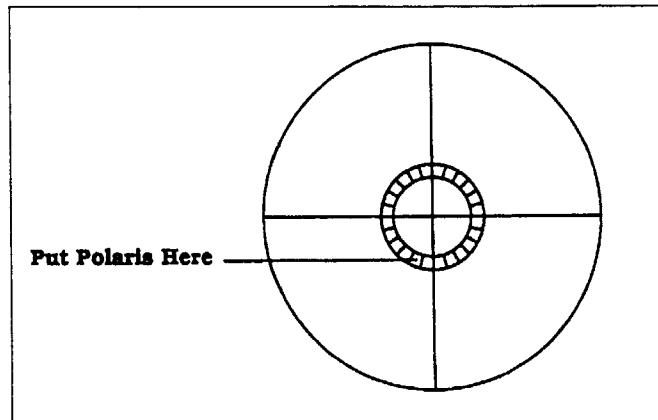
Another general method of polar alignment is by using the Polaris finderscope. Built into the Polaris finder is a reticle with a single cross hair and two circles which will be used for polar alignment. The inner circle is approximately 4/5 of a degree in radius, roughly the distance between Polaris and the celestial pole. In order to use the 7x50 Polaris finder, you

will need two optional parts. The first is the illuminator (#60001) which, among other things, illuminates the cross hairs of the finder. The second thing you are going to need is a Polaris Setting Plate (#60121). This accessory indicates the position of Polaris relative to the celestial pole. Prior to using the finder for polar alignment, it must be aligned with the telescope. To polar align:

- Wait until it is dark enough to see Polaris with the naked eye. Remember, Polaris is the last star in the handle of the Little Dipper.
- Move the telescope, with the tripod attached, until its polar axis is pointing in the general direction of Polaris. (The forks should be pointed toward Polaris.)
- Move the telescope tube to Polaris.
- Hold the Polaris Setting Plate alongside the telescope. The edge with the arrow should point up, away from the northern horizon.
- Rotate the inner circle, which is a graduated hour circle, until your current local time corresponds to the proper date on the outer circle. If this is done during daylight savings time, subtract one hour. The time is listed as a 24 hour clock (i.e., 6:00 PM is 1800 hours, etc.). The date circle lists the months numerically (i.e., January is 1, February is 2, etc.) and there is an indicator for every fifth day. Once this is done, the position of Polaris relative to the celestial pole is indicated by the slanted tab that extends out into the month circle. The numbers 1990 and 2000 show the position of Polaris in 1990 and 2000, respectively.



**Figure 6-8**



**Figure 6-9**

**The Polaris Setting Plate indicates the position of Polaris relative to the celestial pole as seen through the Polaris finder. The center of the Polaris Setting Plate corresponds to the celestial pole while the dated tab corresponds to the position of Polaris.**

With the position provided by the Polaris Setting Plate, you are now ready to polar align your telescope. The outer portion of the month circle (i.e., the two concentric circles) looks exactly like the reticle in the finder. While looking through the finder, move the telescope mount in altitude and azimuth (i.e., vertically and horizontally) until Polaris is in the same position on the reticle as indicated on the Polaris Setting Plate.

Once this is done, your telescope is properly polar aligned and ready for use.

This chapter is basically a list of procedures for operating the Ultima 2000. The procedures are grouped into three sections, Drive System, Alignment, and Pointing. Each of these sections give examples of procedures applicable to the section.

## Drive System

### *Turning the Tracking On and Off*

There are two basic ways a telescope can track the sky, Equatorial tracking and Altazimuth tracking. The Ultima 2000 can track both ways. If you are setting up the telescope to track in Alt-Az, it is easier to have tracking turned OFF during the star alignment process. After you have aligned the telescope, then you would turn the tracking back on. For an equatorially mounted telescope, it is easier to align the telescope to the sky with the tracking turned ON.

| <b><u>BUTTON or ACTION</u></b>  | <b><u>NOTES</u></b>                       | <b><u>DISPLAY</u></b> |
|---|---|-----------------------|
| Turn ON telescope<br>Turn ON hand control<br>If already ON, go to the ALIGN menu. |   | MENU<br>ALIGN         |
| Press UP twice  | Scroll to the SETUP menu                  | MENU<br>SETUP         |
| Press ENTER   | Enter into the SETUP menu.                | SPEED<br>CENTER       |
| Press DOWN  | Scroll down to the TRACK menu             | TRACK<br>OFF          |
| Press ENTER   | Enter into the TRACK menu                 | TRACK<br>OFF          |
| Press DOWN  | Change TRACK setting Altazimuth           | TRACK<br>ALT AZM      |
| Press DOWN twice  | Change TRACK setting to Equatorial North. | TRACK<br>EQ NORTH     |
| Press DOWN once   | Turn TRACK to OFF                         | TRACK<br>OFF          |
| Press MENU  | Return to main menu                       | MENU<br>SETUP         |

For aligning the telescope to the sky in Alt-Az mode, you will want to turn TRACK to OFF. Then when you are aligned, you will need to turn TRACK to ALT AZM.

### ***Changing Slewing Speeds (Button Speed ON)***

---

Here are some examples of how to change the slewing speeds when BTN SPD is turned ON. The BTN SPD option allows the display to jump to the SPEED menu any time a diamond button is pressed. When the diamond button is released, the display returns to its last location. This allows you to change SPEED easily. (For more on BTN SPD see the chapter “Hand Control and Drive Base”) In order to follow this example, set SPEED to CENTER (this can be changed under the SETUP menu).

| <b><u>BUTTON or ACTION</u></b>  | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b> |
|---|---|-----------------------|
| Start at ALIGN menu   | You can be at any menu for this to work, but this example we will be at the ALIGN menu.             | MENU<br>ALIGN         |
| Press the right Diamond button  | The telescope moves at CENTER speed and the display changes to the SPEED option under SETUP         | SPEED<br>CENTER       |
| Release the button  | The display returns to its last location. This is the result of BTN SPEED being in the ON position. | MENU<br>ALIGN         |
| While holding down the right Diamond button press the UP button                   | This changes SPEED to FINDER rate.  | SPEED<br>FINDER       |
| Hold down the right Diamond Button then press the left button simultaneously.     | This leaves SPEED at FINDER but temporarily causes the telescope to move at SLEW speed.             | SPEED<br>FINDER       |
| While holding down the right Diamond button press the UP button                   | This changes SPEED to PHOTO rate.   | SPEED<br>PHOTO        |
| Hold down the right Diamond Button and then press the left button simultaneously. | This leaves SPEED at PHOTO but temporarily causes the telescope to move at CENTER speed.            | SPEED<br>PHOTO        |
| While holding down the right Diamond button press the UP button                   | This changes SPEED to 2 X SDRL.   | SPEED<br>2 X SDRL     |
| While holding down the right Diamond button press the UP button                   | This leaves SPEED at 2 X SDRL but temporarily causes the telescope to move at CENTER speed.         | SPEED<br>CENTER       |

If you are at Photo or 2 X SDRL speed and press one Diamond button then simultaneously press the opposite diamond button, the telescope will jump up to CENTER SPEED. If you are at FINDER speed and press one Diamond button then simultaneously press the opposite diamond button, the telescope will jump up to SLEW SPEED. The display does not change, only the telescope speed changes.

### ***Changing Slewing Speeds (Button Speed OFF)***

---

With BTN SPD set to OFF, the slew rates need to be changed in SETUP under the option called SPEED. Here are a few examples.

| <b><u>BUTTON or ACTION</u></b> | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b> |
|--------------------------------|---|-----------------------|
| Start at SETUP menu            |   | MENU<br>SETUP         |
| Press ENTER                    | Enter into the SETUP menu.  | SPEED<br>CENTER       |
| Press ENTER                    | Enter into SPEED in order to edit the current setting. The “C” is now blinking, so it can be edited with the UP/DOWN buttons. | SPEED<br>CENTER       |

|   |   |                   |
|---|---|-------------------|
| Press UP  | Change SPEED to FINDER rate.  | SPEED<br>FINDER   |
| Press the right Diamond button.   | The telescope moves at 2 degrees per second.  | SPEED<br>FINDER   |
| Hold down the right Diamond Button and then press the left button simultaneously. | This leaves SPEED at FINDER but temporarily causes the telescope to move at SLEW speed.     | SPEED<br>FINDER   |
| Press UP  | Change SPEED to PHOTO.  | SPEED<br>PHOTO    |
| Press UP  | Change SPEED to 2 X SDRL.   | SPEED<br>2 X SDRL |
| Hold down the right Diamond Button and then press the left button simultaneously. | This leaves SPEED at 2 X SDRL but temporarily causes the telescope to move at CENTER speed. | SPEED<br>2 X SDRL |
| Press UP  | Change SPEED to CENTER.   | SPEED<br>CENTER   |
| Press the right Diamond button.   | The telescope moves at center speed. You should be able to hear the motor running.          | SPEED<br>CENTER   |

### *Saving Power*

---

You may want to leave your aligned Ultima 2000 running for extended periods. One example is to leave the aligned telescope ON all night so you can do some daytime observing. There are many stars that can be seen in the day as well as some planets. Jupiter is easily seen through a telescope in the day. But to do this you need to leave the telescope on all night. There are some steps you can take to minimize battery consumption. You need to turn off the tracking motors. There is no reason to have the motors running if you are not looking through the telescope. Also you can turn off the hand control. This will save battery power because the LED is off. Doing this does not upset the telescope's alignment. Here is how to do it.

| <b><u>BUTTON or ACTION</u></b>        | <b><u>NOTES</u></b>  | <b><u>DISPLAY</u></b> |
|---------------------------------------|--|-----------------------|
| Scroll to SETUP menu.                 |  | MENU<br>SETUP         |
| Press ENTER                           | Enter into the SETUP menu.   | SPEED<br>CENTER       |
| Press DOWN                            | Scroll down to the TRACK option of the SETUP menu. We will assume you are in Alt-Az for this example.                        | TRACK<br>ALT AZM      |
| Press ENTER                           | Select the TRACK option.   | TRACK<br>ALT AZM      |
| Use UP/DOWN buttons to scroll to OFF. | Edit the TRACK option by setting tracking to OFF. The telescope does not lose track of the sky, even with tracking OFF.      | TRACK<br>OFF          |
| Press Menu                            | Returns you to the main menu.  | MENU<br>SETUP         |
| Turn hand control to OFF.             | This turns off the hand control operation and turns off the LED display. The telescope will not lose track of its alignment. |                       |

## **Determining the Altitude Backlash Compensation**

---

All drive systems using gears have some amount of backlash. For astrophotography or CCD imaging, this backlash can be a problem. Backlash appears to the user as the time period for which an object in the eyepiece does not move even though the motor is driving. At CENTER speed (which is the fastest speed the tracking motors run) it takes about 1-2 seconds to traverse the backlash dead zone. At 2 X SDRL speed it would take 3-6 seconds to traverse the dead zone. 1-2 seconds is acceptable, but greater than 3 seconds would ruin an astrophoto. By setting the backlash compensation, the deadzone will be traversed at CENTER speed. As the edge of the zone is reached, the speed will drop down to the pre-selected guiding rate; either PHOTO or 2 X SDRL. When the motor is not activated, the compensation sets the drive system in the center of the dead zone. This cuts the time it takes the motors to traverse the dead zone in half.

For a properly set backlash compensation, it should take about half to one second for the object to move in the eyepiece when the rate is set at PHOTO or 2 X SDRL. The star should move smoothly without jumping. If the compensation is set too high, the star will jump suddenly as it overshoots the deadzone, then slow down to the pre-selected guide rate. If it is set too low, the motor will run at CENTER speed then drop down to the guide rate and it will still take a second or more for the object to begin to move.

Here is a procedure for testing the backlash compensation.

1. Set SPEED (under SETUP menu) to 2 X SDRL.
1. Point the telescope at a stationary distant object (in the day) or at Polaris (in the night) and center it in the eyepiece.
1. Press the up DIAMOND button while SPEED is set at 2 X SDRL. The motor will run at full speed for a brief moment then slow down to 2 X SDRL. You know the motor is moving at full speed because you can hear it. When it slows down to 2 X SDRL, you probably won't be able to hear the motor. During the time the motor is running at full speed, you should not see any movement of the object. Only when the motor slows down should the object start to move.
1. Release the button and the object will stop moving and the motor will run at full speed again (too center itself in the dead zone) for a brief moment. The object should not move.
1. If the object moves while the motor is running at full speed, then the backlash compensation is set too high.
  1. If the object doesn't start to move after the motors stop running at full speed, then the backlash is set too low.

If the backlash compensation is set incorrectly, lower or raise the value (under the ALT BACK menu under the SETUP menu) in increments of 50. When you get close to the correct value, use increments of 10. You do not need to get the value more accurate then increments of 10.

## **Finding 90° Declination for Polar Alignment**

---

For polar alignment, it is essential to know when the telescope is pointed straight up, relative to the forks. When the telescope is on a wedge, this is 90° declination. You know when the telescope is pointed straight up, parallel to the forks by using the POSITION menu. Here is how to do it!

| <b><u>BUTTON or ACTION</u></b>      | <b><u>NOTES</u></b>  | <b><u>DISPLAY</u></b> |
|-------------------------------------|--|-----------------------|
| Set the telescope to its downstops. |  |                       |
| Turn telescope and hand control ON. | Turning the telescope ON at the altitude downstop, references the encoder so it knows where it is. | MENU<br>ALIGN         |

|   |  |                          |
|---|--|--------------------------|
| Press DOWN three times.   | Go down to the POSITION menu.  | <b>MENU<br/>POSITION</b> |
| Press ENTER   | Enter into the POSITION menu.  | <b>RA DEC</b>            |
| Press DOWN  | Scroll down to the TELESCOP setting.   | <b>TELESCOP</b>          |
| Press ENTER   | Relative telescope positions are displayed. The bottom number is the altitude axis.  | 174.96<br>-088.85        |
| Point the tube upward until the altitude display reaches a maximum value. | About +090 is straight up relative to the forks. The actual number will be +089.???. | 189.83<br>+089.47        |

The value will not actually be +90°. This is because the telescope has some mechanical characteristics which are unique to each telescope. All telescopes have mechanical characteristics like non-perpendicularity of the two axes, non-parallelism of the optical axis with the mechanical axis, and encoder errors. The Ultima 2000 software accounts for these errors and makes corrections for them. Because of these corrections, the altitude reading will not read 90°. It will reach a maximum value before 90° then start counting down again. The maximum value is the position you should use for polar aligning. You will also notice that when you move the telescope in altitude, the azimuth display will change slightly. This is also due to the computer compensating for the mechanical characteristics of the telescope.

## Alignment

There are several different ways to align the Ultima 2000 to the sky. The most popular way is a two star alignment with the telescope in the Alt-Az configuration. Here are some methods of aligning the Ultima 2000.

### SKY - Two Star Alignment

This is the most popular and the quickest method. It is easiest if you **turn the tracking to OFF** then after the alignment, turn the tracking back on. Do this under the SETUP menu. This method is described in the laminated sheets and is also described in the QUICK SETUP chapter. For the best results, you should pick alignment stars that are at least 20° apart.

| ACTION  | NOTES   | DISPLAY              |
|---|---|----------------------|
| Move the telescope to its downstop positions in both Alt and Az.<br><i>(See the Chapter on the Hand Control, Menu Setup)</i><br>Turn the telescope and hand control ON. | The telescope starts at the ALIGN menu.   | MENU<br>ALIGN        |
| Press ENTER   | Entered into the ALIGN menu and the message "INITIALIZING" scrolls across followed by the prompt to set the azimuth downstop. | SET FORK<br>TO ZERO  |
| Press ENTER   | Initialized the encoder downstop position for azimuth.  | TUBE TO<br>DOWNSTOP  |
| Press ENTER   | Initialized the encoder downstop position for altitude.   | SKY<br>ACHEURNAR     |
| Press ENTER   | Select the SKY option for alignment.  | NEW OBJ<br>ACHEURNAR |
| Use the UP/DOWN buttons to scroll through the list of alignment stars.<br>(example: ALTAIR - press DOWN nine times).  | Scrolled to first alignment star.   | NEW OBJ<br>ALTAIR    |
| Move and center telescope on alignment star and press ENTER   | Aligned the Ultima 2000 to first alignment star.<br><i>NOTE: Move the scope by hand and center with the diamond button.</i>   | SKY<br>ALTAIR        |
| Press ENTER   | Select the SKY option for alignment.  | NEW OBJ<br>ALTAIR    |
| Use the UP/DOWN buttons to scroll to a second alignment star.<br>(Ex: POLARIS - Press DOWN 14 times)  | Scrolled to second alignment star.  | NEW OBJ<br>POLARIS   |
| Move and center telescope on alignment star and press ENTER.  | Aligned to second star and the warp error message displays briefly. An error of less than 0.5 is desirable.                   | NEW OBJ<br>W=(<.5)   |
| A few seconds pass.   | Display returns to the SKY screen after a few seconds.  | SKY<br>POLARIS       |
| Press MENU  | Returns you to the ALIGN Menu.  | MENU<br>ALIGN        |

Now turn the tracking on.

## *EQ North - Polar Aligned, one star alignment*

---

To do a one star alignment, the EQ NORTH setting is available. The only time this is really practical is on a permanent pier mount. This is because it requires an almost perfect polar alignment. Here is how to use a one star EQ NORTH alignment.

| <b>BUTTON or ACTION</b>   | <b>NOTES</b>  | <b>DISPLAY</b>       |
|---|---|----------------------|
| Polar align the telescope using declination drift method. (see chapter, Astro Basics) | See the Polar Alignment section of the chapter Astronomy Basics.  | NA                   |
| Start at the ALIGN menu.  |   | MENU<br>ALIGN        |
| Press ENTER   | Entered into the ALIGN menu and the message "INITIALIZING" scrolls across followed by the prompt to set the azimuth downstop. | SET FORK<br>TO ZERO  |
| Press ENTER   | Initialized the encoder downstop position for azimuth.  | TUBE TO<br>DOWNSTOP  |
| Press ENTER   | Enter into the ALIGN menu.  | SKY<br>ACHERNAR      |
| Press UP  | Scroll to the EQ NORTH menu.  | EQ NORTH<br>ACHERNAR |
| Press ENTER   | Select the EQ NORTH alignment mode.   | NEW OBJ<br>ACHERNAR  |
| Scroll to a name of an alignment star.<br>(ex. ARCTURUS)                              | Alignment star should be at least 20° away from Polaris.  | NEW OBJ<br>ARCTURUS  |
| Move and center telescope to alignment star.  | Use the Diamond buttons to center. Be sure the light, EER is not flashing.  | NEW OBJ<br>ARCTURUS  |
| Press ENTER   | NEW OBJ<br>W=(<.5)  | NEW OBJ<br>W=0.1     |
| Press MENU  | Back to the main menu.  | MENU<br>ALIGN        |

Turn tracking to EQ North setting. See the first section in this chapter.

## *SKY - Updating Alignment*

---

Sometimes you may find it useful to update your alignment during an observing session. Let's say you just slewed to M51, the Whirlpool Galaxy. You decide it would be nice to do an alignment here to increase your accuracy in this part of the sky. You can align to M51. Here is how to do this.

| <b>BUTTON or ACTION</b>             | <b>NOTES</b>   | <b>DISPLAY</b>     |
|-------------------------------------|--|--------------------|
| Center M51 with the Diamond buttons | Your display should be in the GO TO menu, with the Messier catalog displaying M51. | 0°0' 0°0'<br>M 051 |
| Press Menu                          | Back to the main menu.   | MENU<br>GO TO      |
| Press UP                            | Scroll to the ALIGN menu.  | MENU<br>ALIGN      |
| Press ENTER                         | Enter into the ALIGN menu.   | SKY<br>M 051       |
| Press ENTER                         | Enter into the SKY type of alignment.  | NEW OBJ<br>M 051   |
| Press ENTER                         | Align to the object on display   | NEW OBJ<br>W=0.0   |

## ***CHANGE - Changing Alignment Stars***

---

The Ultima 2000 uses two alignment objects to align itself to the sky. If you align to a third object, the telescope replaces the alignment information of one of the previous two alignment objects. The software automatically replaces the alignment information of the nearest object to the new object. This ensures that the alignment stars are not too close to each other.

In some cases you may want to override this procedure. If so, here is how to use the CHANGE option in the ALIGN menu. For this example, let's assume the telescope is aligned to Spica and Regulus and you want to replace Regulus with Arcturus.

| <b>BUTTON or ACTION</b>   | <b>NOTES</b>   | <b>DISPLAY</b>      |
|---|--|---------------------|
| Start at the ALIGN menu.  |  | MENU<br>ALIGN       |
| Press DOWN twice.   | Make sure we are in the NAMED STAR CATALOG.  | MENU<br>CATALOG     |
| Press ENTER and use the UP/DOWN buttons to find NAMED STAR CATALOG.   | Scroll to NAMED STAR   | NAMED<br>STAR       |
| Press MENU and UP twice.  | Scroll to the ALIGN menu.  | MENU<br>ALIGN       |
| Press ENTER   | Enter into the ALIGN menu.   | SKY<br>REGULUS      |
| Press DOWN twice  | Scroll to the CHANGE option of the ALIGN menu.   | CHANGE<br>REGULUS   |
| Press ENTER, then scroll to Arcturus.   | Select the CHANGE option and scroll to the desired alignment object.                                       | NEW OBJ<br>ARCTURUS |
| Press ENTER   | Select Arcturus as the new alignment object. The first of the two previous alignment objects is displayed. | OLD OBJ<br>SPICA    |
| Press DOWN  | Switch to the other alignment star.  | OLD OBJ<br>REGULUS  |
| <i>If you want to abort the change and new alignment or just check to see what the alignment stars are, press MENU. Pressing MENU puts you back to the main menu without changing anything. Don't press MENU to continue with this example.</i> |  |                     |
| Press ENTER   | Replace REGULUS with ARCTURUS as the second alignment object.  | OLD OBJ<br>W=-0.1   |
| A few seconds pass  | Display returns to the CHANGE option.  | CHANGE<br>ARCTURUS  |
| Press MENU  | Return to the main menu.   | MENU<br>ALIGN       |

## ***SKY - One Star Alignment***

---

A one star alignment is a rough way to align the telescope to the sky so it will track in the Alt-Az configuration. The idea is to align to an object, wait for 5 to 10 minutes, then align to the object again. This is useful for situations when few stars are visible, like just after sunset. This is also useful if you want to do some Alt-Az solar observing. The only object to align to would be the Sun. This method gives you a rough sky alignment. This alignment is good enough to track in Alt-Az, but may not be very good for pointing accuracy.

| <u>ACTION</u>  | <u>NOTES</u>  | <u>DISPLAY</u>      |
|--|---|---------------------|
| Move the telescope to its downstop positions in both Alt and Az.<br><i>(See the Chapter on the Hand Control, Menu Setup)</i> | The telescope always starts off at the ALIGN menu.  | MENU<br>ALIGN       |
| Turn the telescope ON<br>Turn the hand control ON  |   |                     |
| Press ENTER  | Entered into the ALIGN menu and the message "INITIALIZING" scrolls across followed by the prompt to set the azimuth downstop. | SET FORK<br>TO ZERO |
| Press ENTER  | Initialized the encoder downstop position for azimuth.  | TUBE TO<br>DOWNSTOP |
| Press ENTER  | Initialized the encoder downstop position for altitude.   | SKY<br>ACHERNAR     |
| Press ENTER  | Select the SKY option for alignment.  | NEW OBJ<br>ACHERNAR |
| Use the UP/DOWN buttons to scroll through the list of alignment stars.<br>(example: ALTAIR - press DOWN nine times)          | Scrolled to first alignment star.   | NEW OBJ<br>ALTAIR   |
| Move and center telescope on alignment star and press ENTER.   | Align the Ultima 2000 to first alignment star.<br><i>NOTE: Move the scope by hand and center with the diamond buttons)</i>    | SKY<br>ALTAIR       |
| Press ENTER  | Selects the SKY option for alignment. (Now the cursor is at the "A" for Altair)   | NEW OBJ<br>ALTAIR   |
| Press ENTER  | Aligned to Altair and a large warp value was given (in most cases)  | NEW OBJ<br>W=(??)   |
| Wait 5 to 10 minutes   | During this time the star will move due to the Earth's rotation.  | SKY<br>ALTAIR       |
| Center the telescope on the same alignment star and Press ENTER  | Selects the SKY option for alignment. (Now the cursor is at the "A" for Altair)   | NEW OBJ<br>ALTAIR   |
| Press Enter  | Aligns on the same star again.  | W= X.X (X<5)        |
| A few seconds pass.  | Display returns to the SKY screen after a few seconds.  | SKY<br>ALTAIR       |

The telescope is now aligned to the sky to a small degree of accuracy and will track in Alt-Az mode. The pointing accuracy for this method will most likely be within the Finderscope but unlikely in the eyepiece. The longer the period between alignments will increase the accuracy. This method is meant for someone who only knows one star. At this point the telescope can be used to point to another alignment star. Align to the second star to gain better alignment.

## **EARTH - Terrestrial Alignment**

---

The Ultima 2000 can be used as a spotting scope on terrestrial objects. It is possible to align to objects of interest so you can slew back and forth between them. Say you are looking at two different bird nests, you can align to them and automatically slew back and forth between them. You can define terrestrial objects in the NEW Catalog and then slew between them. Furthermore, if you set up the telescope the next day in the same location and align to two of the NEW objects you programmed into the NEW database, you can slew around to all the objects again. To do this though, you must set up in the same spot to avoid a parallax effect. Here is how to align to terrestrial objects.

| <b>BUTTON or ACTION</b>  | <b>NOTES</b>  | <b>DISPLAY</b>             |
|--|---|----------------------------|
| Turn the telescope and hand control ON and turn tracking rate OFF. Return to the ALIGN menu. |   | MENU<br>ALIGN              |
| Place the telescope to its downstops and press ENTER.  |   | SET FORK<br>TO ZERO        |
| Press ENTER  | Aligns the azimuth downstop.  | TUBE TO<br>DOWNSTOP        |
| Press ENTER  | Aligns the altitude downstop.   | SKY<br>ACHERNAR            |
| Press DOWN once.   | Scroll to the EARTH option under the ALIGN menu.  | EARTH<br>ACHERNAR          |
| Press MENU   | Return to the main menu.  | MENU<br>ALIGN              |
| Find an object you would like to define as a NEW object. Center the telescope on the object. |   | MENU<br>ALIGN              |
| Press DOWN twice.  | Scroll to the CATALOG menu.   | MENU<br>CATALOG            |
| Press ENTER  | Enter into the CATALOG menu.  | NAMED<br>STAR              |
| Press DOWN once.   | Scroll to the NEW object catalog.   | NEW01                      |
| Press ENTER  | Enter the NEW catalog and place the cursor at the leading zero.   | NEW01                      |
| Press ENTER  | Place the cursor at the second digit.   | NEW01                      |
| Press ENTER  | View the current coordinates stored in the NEW catalog.   | 0000+000<br>NEW01          |
| Press ENTER  | This allows you to set the coordinates to the position the telescope is pointed.                            | SET TO<br>CUR POSN         |
| Press ENTER  | Set the coordinates to the NEW position.  | 0320+420(example)<br>NEW01 |
| Press MENU, Press UP twice, Press ENTER.   | Go to the ALIGN menu and scroll to EARTH mode. EARTH mode sets the passage of sidereal time to zero.        | EARTH<br>NEW01             |
| Press ENTER  | If you decide you don't want to name the object NEW01, then use the UP DOWN arrows here to change the name. | NEW OBJ<br>NEW01           |
| Press ENTER  | Align to the object.  | EARTH<br>NEW01             |

|  |  |                            |
|--|--|----------------------------|
| Press Menu, Press DOWN 2X, Press ENTER.              | Enter into the CATALOG menu.   | NEW01                      |
| Press ENTER, Press ENTER, Press UP.                  | Change to a different NEW object, for this example NEW02.                              | NEW02                      |
| Press ENTER, Press ENTER.                            | This allows you to set the coordinates to the position the telescope is pointed.       | SET TO CUR POSN            |
| Find another object and center it in the telescope.  |  | SET TO CUR POSN            |
| Press ENTER  | Set the coordinates to the NEW position.   | 1234+543(example)<br>NEW02 |
| Press the MENU button and go back to the ALIGN menu. |  | MENU<br>ALIGN              |
| Press ENTER  | Enter into the ALIGN menu.   | EARTH<br>NEW02             |
| Press ENTER  | Choose the EARTH option under the ALIGN menu.  | NEW OBJ<br>NEW02           |
| Press ENTER  | Align to object. A warp displays for a few seconds, then the display returns to EARTH. | EARTH<br>NEW02             |

Now you are aligned to two terrestrial objects. You can slew back and forth between them and you can also define NEW objects 3-27 as other terrestrial objects. But when you define other objects, you can skip the align operations because you are already aligned. If you want to view these same terrestrial objects after turning off the telescope, you need to align to any two NEW objects. It is important to make a note for yourself which terrestrial object is in what NEW memory position if you plan on aligning to them again later. It is also important that the telescope is set up in the same location so the relative positions of the terrestrial objects have not changed.

#### ***EARTH - Terrestrial Alignment to User Defined NEW Objects***

---

Let's say you have previously defined a few terrestrial objects of interest that you would like to align the Ultima 2000 to again. Since the objects are already in the user defined NEW database, all you have to do is align the telescope to any two of them. Here is how.

| BUTTON or ACTION   | NOTES   | DISPLAY             |
|--|---|---------------------|
| Set the telescope up in the same location as when you defined the objects. |   |                     |
| Turn the scope ON and set it to the downstops. (Turn tracking OFF)         |   | MENU<br>ALIGN       |
| Press ENTER  | This is to set the downstops.                         | SET FORK<br>TO ZERO |
| Press ENTER  | Define the azimuth downstop.                          | TUBE TO<br>DOWNSTOP |
| Press ENTER  | Define the altitude downstop.                         | SKY<br>ACHERNAR     |
| Press MENU, scroll to CATALOG.   |   | MENU<br>CATALOG     |
| Press ENTER, press DOWN.   | Let's assume you are going to align to NEW01 first.   | NEW01               |
| Press MENU, scroll back to ALIGN. Press ENTER.                             | Enter into the ALIGN menu.                            | SKY<br>NEW01        |
| Press DOWN   | Scroll down to the EARTH option under the ALIGN menu. | EARTH<br>NEW01      |

|  |  |                  |
|--|--|------------------|
| Move the telescope to the object you previously defined as NEW01. Center it in the eyepiece. |  | EARTH<br>NEW01   |
| Press ENTER, Press ENTER   | Perform an align operation on NEW01.   | EARTH<br>NEW01   |
| Move the telescope to another previously defined NEW object. Let's say NEW03.                |  | EARTH<br>NEW01   |
| Press ENTER  | Enter into the EARTH option.   | NEW OBJ<br>NEW01 |
| Press UP 2X  | Choose the NEW object you want to align to.  | NEW OBJ<br>NEW03 |
| Press ENTER  | Perform an align operation on the NEW object.  | EARTH<br>W= -0.1 |
| Press MENU   | Return to the main menu. Now you can slew to any of the NEW objects you have programmed into the database. | MENU<br>ALIGN    |

You are now aligned to the terrestrial objects you defined in your user definable NEW catalog. You can slew to any of the objects now. You can only slew to the objects that you programmed into the database for a particular observing site.

#### *Finding 90° Declination for Polar Alignment*

---

For polar alignment, it is essential to know when the telescope is pointed straight up, relative to the forks. When the telescope is on a wedge, this is 90° declination. You know when the telescope is pointed straight up, parallel to the forks by using the POSITION menu. Here is how to do it!

| <b>BUTTON or ACTION</b>   | <b>NOTES</b>   | <b>DISPLAY</b>    |
|---|--|-------------------|
| Set the telescope to its downstops.                                       |  |                   |
| Turn telescope and hand control ON.                                       | Turning the telescope ON at the altitude downstop, references the encoder so it knows where it is. | MENU<br>ALIGN     |
| Press DOWN three times.   | Go down to the POSITION menu.  | MENU<br>POSITION  |
| Press ENTER   | Enter into the POSITION menu.  | RA DEC            |
| Press DOWN  | Scroll down to the TELESCOP setting.   | TELESCOP          |
| Press ENTER   | Relative telescope positions are displayed. The bottom number is the altitude axis.                | 174.96<br>-088.85 |
| Point the tube upward until the altitude display reaches a maximum value. | About +090 is straight up relative to the forks. The actual number will be +089.???                | 189.83<br>+089.47 |

The value will not actually be +90°. This is because the telescope has some mechanical characteristics which are unique to each telescope. All telescopes have mechanical characteristics like non-perpendicularity of the two axes, non-parallelism of the optical axis with the mechanical axis, and encoder errors. The Ultima 2000 software accounts for these

errors and makes corrections for them. Because of these corrections, the altitude reading will not read 90°. It will reach a maximum value before 90° then start counting down again. The maximum value is the position you should use for polar aligning. You will also notice that when you move the telescope in altitude, the azimuth display will change slightly. This is also due to the computer compensating for the mechanical characteristics of the telescope.

## Pointing

### *GO TO Command*

This is the command that tells the telescope to slew to an object. To use this command, the telescope needs to be previously aligned.

| <b>BUTTON or ACTION</b>                | <b>NOTES</b>   | <b>DISPLAY</b>             |
|--|--|----------------------------|
| Start at the ALIGN menu.               |  | MENU<br>ALIGN              |
| Press DOWN twice.                      | Scroll to the CATALOG menu. Here you can find the object you want to look at.                                  | MENU<br>CATALOG            |
| Press ENTER                            | Enter into the CATALOG menu.   | NAMED<br>STAR              |
| Press UP                               | Scroll up to the NAMED OBJECT catalog.   | NAMED<br>OBJECT            |
| Press ENTER                            | Enter into the NAMED OBJECT catalog.   | 0043+413<br>ANDROMED       |
| Press ENTER                            | While the message scrolls across the bottom, you are at GO TO.   | GO TO<br>Scrolling Message |
| Press ENTER while display reads GO TO. | The telescope slews to Andromeda Galaxy.   | 0043+413<br>ANDROMED       |
| Press MENU                             | Return to the main menu.   | MENU<br>CATALOG            |
| Press UP                               | Scroll to the GO TO menu.  | MENU<br>GO TO              |
| Press ENTER                            | Enter into the GO TO menu. Notice that you are still in the NAMED OBJECT CATALOG and last object is displayed. | AUTO<br>ANDROMED           |
| Press DOWN                             | Choose the MANUAL option.  | MANUAL<br>ANDROMED         |
| Press ENTER                            | Enter into the MANUAL option.  | 0°0 0°0<br>ANDROMED        |
| Press DOWN until you reach PINWHEEL.   | Scroll down the list of named objects.   | 12← 5↓2<br>PINWHEEL        |
| Press ENTER two times.                 | The telescope will slew to the object.   | 0°0 0°0<br>PINWHEEL        |

### *Increasing Pointing Accuracy using Enhanced Encoder Resolution - EER*

The Ulti.na 2000 has optical encoders on both axes. The resolution of each encoder is 2.5 arc minutes. Using the enhanced encoder resolution gives the telescope eight times better resolution, approximately 19 arc seconds. This is the maximum theoretical pointing accuracy. In order to use EER, you must center alignment objects with the tracking motors. The blinking light on the drive base indicates what state the resolution is in. Blinking about once a second

means the telescope is in standard resolution mode, 2.5 arc minutes. Blinking twice a second means one of the axes is in EER. When both axes are in EER, the light stays on. This is the goal. Here is a demonstration you can try to get EER activated.

- Turn the telescope and hand control ON.
- Turn Tracking OFF
- Set SPEED to CENTER.
- Press the right Diamond button until the blinking light changes to 2 times a second. Now the azimuth is in EER.
- Press the UP button until the light stops blinking. Now both axis are in EER.
- Move azimuth by hand. Notice the light starts blinking at two times a second again. Now azimuth has been taken out of EER.
- Move the altitude by hand and the light will start blinking once per second. Now EER is not activated on either axis.

To center an alignment star, it is good practice to move the telescope by hand until the star is in the field of view. Then, use the diamond buttons at CENTER speed to center the star. Check to be sure that the light is not blinking. Then press ENTER to align.

You will notice, whenever the telescope slews to an object, it always finishes the slew in EER. But if you don't align the telescope in EER, the accuracy is diminished. **You should use a reticle eyepiece to center the alignment stars.**

#### **Precise Pointing - Relative Command**

---

This is a more accurate way of pointing the telescope, but takes a little bit longer. If you use the RELATIVE GO TO command, the computer searches through its database for the brightest star within 5° of the object you are trying to go to. After the computer locates the star, it will slew to the star. Then you center the reference star. The computer uses this new information to find the object. Here is how to use the RELATIVE command.

(The telescope must be aligned (on a wedge or Alt-Az) to use the RELATIVE command)

| <b><u>BUTTON or ACTION</u></b>                                       | <b><u>NOTES</u></b>   | <b><u>DISPLAY</u></b> |
|--|---|-----------------------|
| Start at the GO TO menu.   |   | MENU<br>GO TO         |
| press ENTER  | For this example we will use M81 as the target.   | AUTO<br>M 081         |
| press UP   | Scroll to RELATIVE  | RELATIVE<br>M 081     |
| press ENTER  | Activate a search through the database for a reference star. Then telescope slews to the star.      | RELATIVE<br>SLEWING   |
| Telescope slews by itself.   |   | CENTER                |
| Center the brightest star in the field by using the Diamond buttons. | You should set diamond buttons to CENTER speed or 2 X SDRL. A reticle eyepiece should be used here. | CENTER                |
| press ENTER  | The telescope slews and centers the object.   | 0°0' 0°0'<br>M 081    |

## **CHAPTER 6: DEEP SKY OBSERVING**

With your telescope set up, you are ready to use it for observing. This section covers visual observing for both solar system and deep sky objects.

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### **Observing the Moon**

In the night sky, the Moon is a prime target for your first look because it is extremely bright and easy to find. Often, it is tempting to look at the Moon when it is full. At this time, the face we see is fully illuminated and its light can be overpowering. In addition, little or no contrast can be seen during this phase.

One of the best times to observe the Moon is during its partial phases (around the time of first or third quarter). Long shadows reveal a great amount of detail on the lunar surface. At low power you will be able to see most of the lunar disk at one time. The optional Reducer/Corrector lens allows for breathtaking views of the entire lunar disk when used with a low power eyepiece. Change to higher power (magnification) to focus in on a smaller area. Keep in mind that if you are not using the clock drive, the rotation of the Earth will cause the Moon to drift out of your field of view. You will have to manually adjust the telescope to keep the Moon centered. This effect is more noticeable at higher power. If you are using the clockdrive and have polar aligned, the Moon will remain centered if using the lunar tracking rate. Consult your local newspaper or a current astronomy magazine to find out when the Moon is visible.

---

#### **Lunar Observing Hints**

- To ensure accurate tracking, be sure to select the lunar tracking rate.
- To increase contrast and bring out detail on the lunar surface, use filters. A yellow filter works well at improving contrast.

---

### **Observing the Planets**

Other easy targets include the five naked eye planets. You can see Venus go through its lunar-like phases. Mars can reveal a host of surface detail and one, if not both, of its polar caps. You will be able to see the cloud belts of Jupiter and the great Red Spot (if it is visible at the time you are observing). In addition, you will also be able to see the moons of Jupiter as they orbit the giant planet. Saturn, with its beautiful rings, is easily visible at moderate power. All you need to know is where to look. Most astronomy publications indicate where the planets are in the sky each month.

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#### **Planetary Observing Hints**

- King or sidereal rates work best for tracking the planets.
- To increase contrast and bring out detail on the planetary surface, try using Celestron eyepiece filters.

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### **Observing the Sun**

Although overlooked by many amateur astronomers, solar observation is both rewarding and fun. However, because the Sun is so bright, special precautions must be taken when observing our star so as not to damage your eyes or your telescope.

Never project an image of the Sun through the telescope. Because of the folded optical design, tremendous heat build-up will result inside the optical tube. This can damage the telescope and/or any accessories attached to the telescope.

For safe solar viewing, use a Celestron solar filter. This filter reduces the intensity of the Sun's light, making it safe to view. With this filter you can see sunspots as they move across the solar disk and faculae, which are bright patches seen near the Sun's edge. Be sure to cover the lens of the finder or completely remove the finderscope when observing the Sun. This will ensure that the finderscope itself is not damaged and that no one looks through it inadvertently.

### ***Solar Observing Hints***

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- The best time to observe the Sun is in the early morning or late afternoon when the air is cooler.
- To locate the Sun without a finder, watch the shadow of the telescope tube until it forms a circular shadow.
- To ensure accurate tracking, be sure to select the solar tracking rate.

---

## **Observing Deep Sky Objects**

Deep-sky objects are simply those objects outside the boundaries of our solar system. They include star clusters, planetary nebulae, diffuse nebulae, double stars and other galaxies outside our own Milky Way. Unlike the Sun, Moon, and five major planets, most deep sky objects are not visible to the naked eye. The Ultima 2000 can find these objects for you. The Celestron Sky Maps (#93722) can help you decide what objects are visible, or the TOUR feature can show you some objects that are visible during your observing session.

Most deep-sky objects have a large angular size. Therefore, low-to-moderate power is all you need to see them. Visually, they are too faint to reveal any of the color seen in long exposure photographs. Instead, they appear black and white. And, because of their low surface brightness, they should be observed from a dark-sky location. Light pollution around large urban areas washes out most nebulae making them difficult, if not impossible, to observe. Light Pollution Reduction filters help reduce the background sky brightness, thus increasing contrast.

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## **Seeing Conditions**

Viewing conditions affect what you can see through your telescope during an observing session. Conditions include transparency, sky illumination, and seeing. Understanding viewing conditions and the effect they have on observing will help you get the most out of your telescope.

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### ***Transparency***

Transparency is the clarity of the atmosphere which is affected by clouds, moisture, and other airborne particles. Thick cumulus clouds are completely opaque while cirrus clouds can be thin, allowing the light from the brightest stars through. Hazy skies absorb more light than clear skies making fainter objects harder to see and reducing contrast on brighter objects. Aerosols ejected into the upper atmosphere from volcanic eruptions also affect transparency. Ideal conditions are when the night sky is inky black.

---

### ***Sky Illumination***

General sky brightening caused by the Moon, aurorae, natural airglow, and light pollution greatly affect transparency. While not a problem for the brighter stars and planets, bright skies reduce the contrast of extended nebulae making them difficult, if not impossible, to see. To maximize your observing, limit deep sky viewing to moonless nights far from the light polluted skies found around major urban areas. LPR filters enhance deep sky viewing from light polluted areas by

blocking unwanted light while transmitting light from certain deep sky objects. You can, on the other hand, observe planets and stars from light polluted areas or when the Moon is out.

## Seeing

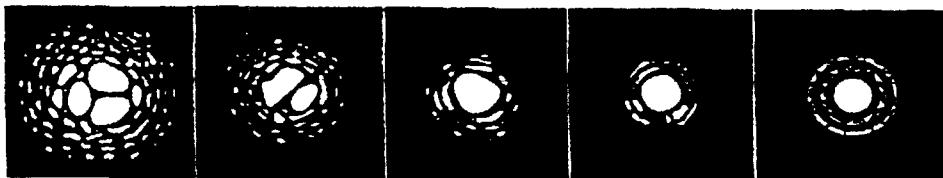
Seeing conditions refer to the stability of the atmosphere and directly affects the amount of fine detail seen in extended objects. The air in our atmosphere acts as a lens which bends and distorts incoming light rays. The amount of bending depends on air density. Varying temperature layers have different densities and, therefore, bend light differently. Light rays from the same object arrive slightly displaced creating an imperfect or smeared image. These atmospheric disturbances vary from time-to-time and place-to-place. The size of atmospheric turbulent cells compared to your aperture determines the "seeing" quality. Under good seeing conditions, fine detail is visible on the brighter planets like Jupiter and Mars, and stars are pinpoint images. Under poor seeing conditions, images are blurred and stars appear as blobs. Seeing conditions are rated on five-point scale where one is the worst and five is the best (see Figure 9-1). Seeing conditions can be classified in one of three categories which are based on the cause.

Type 1 seeing conditions are characterized by rapid changes in the image seen through the telescope. Extended objects, like the Moon, appear to shimmer while point sources (i.e., stars) appear double. Type 1 seeing is caused by currents within or very close to the telescope tube. These currents could be caused by a telescope that has not reached thermal equilibrium with the outdoor surroundings, heat waves from people standing near the telescope, or heated dew caps. To avoid the problems associated with Type 1 seeing, allow your telescope approximately 45 minutes to reach thermal equilibrium. Once adjusted to the outdoor temperature, don't touch the telescope tube with your hands. When pointing the telescope, hold the Ultima by the handle on the rear cell. If observing with others, make sure no one stands in front of or directly below the telescope tube.

The images produced by Type 2 seeing conditions don't move as quickly as those produced by Type 1 conditions, but the images are quite blurry. Fine detail is lost and the contrast is low for extended objects. Stars are spread out and not sharp. The source of Type 2 seeing is the lower atmosphere, most likely heat waves from the ground or buildings. To avoid the problems associated with Type 2 seeing, select a good observing site. Look for broad hill tops or open grassy fields. Stable thermal conditions found near lakes and atmospheric inversions also tend to produce good seeing. Avoid sites that overlook asphalt parking lots or plowed fields. Stay away from valleys and shorelines. If you can't get a better location, wait until the early morning hours when the surroundings are uniformly cool and the seeing is generally better.

Type 3 seeing conditions are characterized by fast ripples, but sharp images. In extended objects fine detail is visible, but the images shift around the field. Stars are crisp points, but they shift small distances rapidly around the field. The cause of Type 3 seeing is turbulence in the upper atmosphere which means the observer has less control over it. However, the effects of Type 3 seeing are generally less pronounced than the other two types. You can never really avoid Type 3 seeing. Your best bet is to wait until moments of steadiness. If the seeing is extremely bad, pack up and wait for a better night.

The conditions described here apply to both visual and photographic applications.



**Figure 8-1** Seeing conditions directly affect image quality. These drawings represent a point source (i.e., star) under bad seeing conditions (left) to excellent condition (right). Most often, seeing conditions produce images that lie somewhere between these two extremes.



**Note:** All the different types of photography described in this chapter will require the use of an optional wedge for polar aligning the telescope.

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## Celestial Photography

After looking at the night sky for a while you may want to try photographing it. Several forms of celestial photography are possible with your Celestron telescope. The most common forms of celestial photography, in order of difficulty are; short exposure prime focus, piggyback, eyepiece projection, and long exposure deep sky. Each of these is discussed in moderate detail with enough information to get you started. Topics include the accessories required and some simple techniques.

In addition to the specific accessories required for each type of celestial photography, there is the need for a camera - but not just any camera. The camera does not need many of the features offered on today's state-of-the-art equipment. For example, you don't need auto focus capability or mirror lock up. Here are the mandatory features a camera needs for celestial photography. First, a 'B' setting which allows for time exposures. This excludes point and shoot cameras and limits the selection to SLR cameras, the most common type of 35mm camera on the market today.

Second, the 'B' or manual setting should NOT run off the battery. Many new electronic cameras use the battery to keep the shutter open during time exposures. Once the batteries are drained, usually after a few minutes, the shutter closes, whether you were finished with the exposure or not. Look for a camera that has a manual shutter when operating in the time exposure mode. Olympus, Nikon, Minolta, Pentax, Canon and others have made such camera bodies.

The camera must have interchangeable lenses so you can attach it to the telescope and so you can use a variety of lenses for piggyback photography. If you can't find a new camera, you can purchase a used camera body that is not 100-percent functional. The light meter, for example, does not have to be operational since you will be determining the exposure length manually.

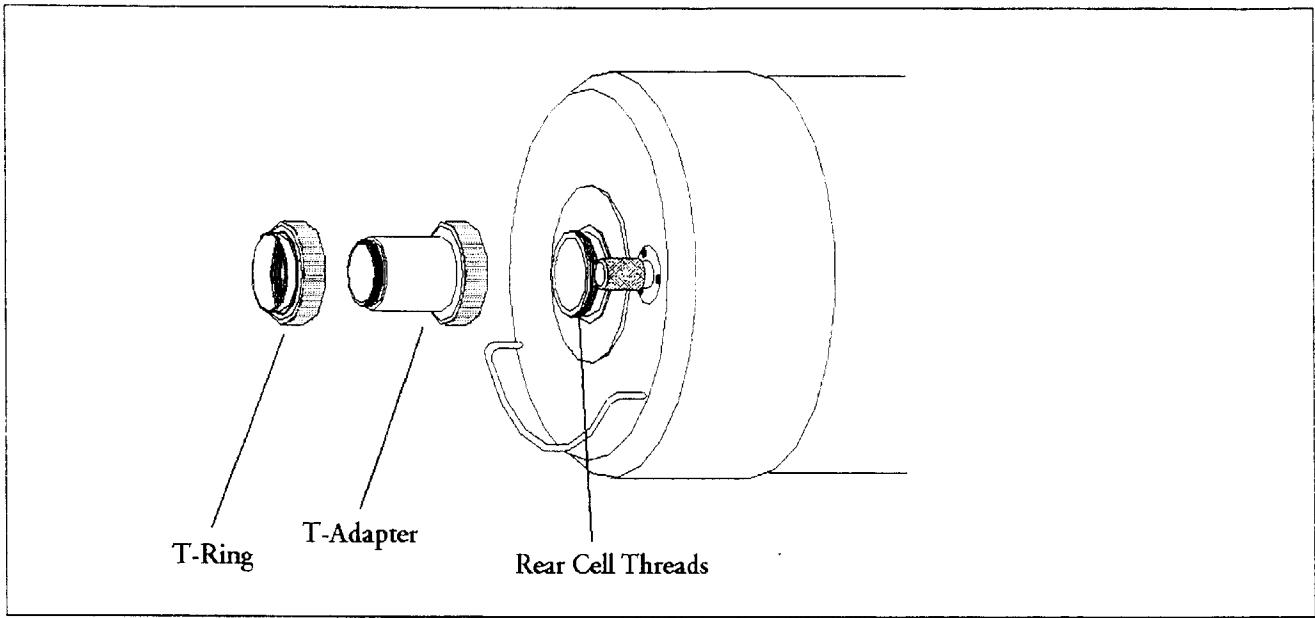
You also need a cable release with a locking function to hold the shutter open while you do other things. Mechanical and air release models are available.

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## Short Exposure Prime Focus Photography

Short exposure prime focus photography is the best way to begin recording celestial objects. It is done with the camera attached to the telescope without an eyepiece or camera lens in place. To attach your camera you need the Celestron T-Adapter (#93633-A) and a T-Ring for your specific camera (i.e., Minolta, Nikon, Pentax, etc.). The T-Ring replaces the 35mm SLR camera's normal lens. Prime focus photography allows you to capture the majority of the lunar disk or solar disk. To attach your camera to your Ultima Telescope:

1. Remove all visual accessories.
2. Thread the T-Ring onto the T-Adapter. (See Figure 9-1)
3. Mount your camera body onto the T-Ring the same as you would any other lens.
4. Thread the T-Adapter onto the back of the Celestron Telescope while holding the camera in the desired orientation (either vertical or horizontal).



**Figure 9-1**

With your camera attached to the telescope, you are ready for prime focus photography. Start with an easy object like the Moon. Here's how to do it:

1. Load your camera with film that has a moderate-to-fast speed (i.e., ISO rating). Faster films are more desirable when the Moon is a crescent. When the Moon is near full, and at its brightest, slower films are more desirable. Here are some film recommendations:
  - T-Max 100
  - T-Max 400
  - Any 100 to 400 ISO color slide film
  - Fuji Super HG 400
  - Ektar 25 or 100
2. Center the Moon in the field of your Ultima Telescope.
3. Focus the telescope by turning the focus knob until the image is sharp.
4. Set the shutter speed to the appropriate setting (see Table 9-1).
5. Trip the shutter using a cable release.
6. Advance the film and repeat the process.

| Lunar Phase | ISO 50 | ISO 100 | ISO 200 | ISO 400 |
|-------------|--------|---------|---------|---------|
| Crescent    | 1/2    | 1/4     | 1/8     | 1/15    |
| Quarter     | 1/15   | 1/30    | 1/60    | 1/125   |
| Full        | 1/30   | 1/60    | 1/125   | 1/250   |

**Table 9-1** Above is a listing of recommended exposure times when photographing the Moon at the prime focus of your Celestron Ultima Telescope.

The exposure times listed in Table 9-1 should be used as a starting point. Always make exposures that are longer and shorter than the recommended time. Also, take a few photos at each shutter speed. This will ensure that you will get a good photo. If using black and white film, try a yellow filter to reduce the light intensity and to increase contrast.

Keep accurate records of your exposures. This information is useful if you want to repeat your results or if you want to submit some of your photos to various astronomy magazines for possible publication!

This technique is also used for photographing the Sun with the proper Celestron solar filter.

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## Piggyback Photography

The easiest way to enter the realm of deep-sky, long exposure astrophotography is via the piggyback method. Piggyback photography is done with a camera and its normal lens riding on top of the telescope. The telescope is mounted on a wedge and is polar aligned. Through piggyback photography you can capture entire constellations and record large scale nebulae that are too big for prime focus photography. Because you are photographing with a low power lens and guiding with a high power telescope, the margin for error is very large. Small mistakes made while guiding the telescope will not show up on film. To attach the camera to the telescope, use the piggyback mount. This can be purchased as an optional accessory.

As with any form of deep-sky photography, it should be done from a dark sky observing site. Light pollution around major urban areas washes out the faint light of deep-sky objects.

1. Polar align the telescope (using one of the methods described earlier) and start the clock drive.
2. Load your camera with slide or print film, ISO 400 or faster!
3. Attach the camera with a normal or wide angle lens to the piggyback mount.
4. Set the f/ratio of your camera lens so that it is a half stop to one full stop down from completely open.
5. Set the shutter speed to the "B" setting and focus the lens to the infinity setting.
6. Locate the area of the sky that you want to photograph and move the telescope so that it points in that direction.
7. Find a suitable guide star in the telescope field. This is relatively easy since you can search a wide area without affecting the area covered by your camera lens. If you do not have an illuminated cross hair eyepiece for guiding, simply defocus your guide star until it fills most of the field of view. This makes it easy to detect any drift.
8. Release the shutter using a cable release.
9. Monitor your guide star for the duration of the exposure making all corrections using the hand controller.
10. Close the camera's shutter.

As for lenses, use only those that produce sharp images near the edge of the field. The lenses should have a resolving power of at least 40 lines per millimeter. A good focal length range is 35 to 200mm for lenses designed for 35mm cameras.

The exposure time depends on the film being used. However, five minutes is usually a good starting point. With slower films, like ISO 100, you can expose as long as 45 minutes. With faster films, like ISO 1600, you really shouldn't expose more than 5 to 10 minutes. When getting started, use fast films to record as much detail in the shortest possible time. Here are proven recommendations:

- Ektar 1000 (color print)
- Konica 3200 (color print)
- Fujichrome 1600D (color slide)
- 3M 1000 (color slide)
- T-Max 3200 (black and white print)
- T-Max 400 (black and white print)

As you perfect your technique, try using specialized films that are designed or specially treated for celestial photography. Here are some popular choices:

- Ektar 125 (color print)
- Fujichrome 100D (color slide)
- Tech Pan, gas hypered (black and white print)
- T-Max 400 (black and white print)

As with all forms of photography, keep accurate records of your work. This information can be used later if you want to reproduce certain results or if you want to submit photos for possible publication.

Once you have mastered piggyback photography with wide angle and normal lenses, try longer focal length lenses. The longer the focal length, the more accurate your guiding must be. You can continue to increase the focal length of the lens until you are ready for prime focus photography with your Celestron Ultima Telescope.

## **Eyepiece Projection**

This form of celestial photography is designed for objects with small angular sizes, primarily the Moon and planets. Planets, although physically quite large, appear small in angular size because of their great distances. Moderate to high magnification is, therefore, required to make the image large enough to see any detail. Unfortunately, the camera/telescope combination alone does not provide enough magnification to produce a usable image size on film. In order to get the image large enough, you must attach your camera to the telescope with the eyepiece in place. To do so, you need two additional accessories; a deluxe tele-extender (#93643), which attaches to the visual back, and a T-ring for your particular camera make (i.e., Minolta, Nikon, Pentax, etc.).

Because of the high magnifications during eyepiece projection, the field of view is quite small which makes it difficult to find and center objects. To make the job a little easier, align the finder as accurately as possible. This allows you to get the object in the telescope's field based on the finder's view alone.

Another problem introduced by the high magnification is vibration. Simply tripping the shutter — even with a cable release — produces enough vibration to smear the image. To get around this, use the camera's self-timer if the exposure time is less than one second — a common occurrence when photographing the Moon. For exposures over one second, use the "hat trick." This technique incorporates a hand-held black card placed over the aperture of the telescope to act as a shutter. The card prevents light from entering the telescope while the shutter is released. Once the shutter has been released and the vibration has diminished (a few seconds), move the black card out of the way to expose the film. After the exposure is complete, place the card over the front of the telescope and close the shutter. Advance the film and you're ready for your next shot. Keep in mind that the card should be held a few inches in front of the telescope, and not touching it. It is easier if you use two people for this process; one to release the camera shutter and one to hold the card. Here's the process for making the exposure.

1. Find and center the desired target in the view finder of your camera.
2. Turn the focus knob until the image is as sharp as possible.
3. Place the black card over the front of the telescope.
4. Release the shutter using a cable release.

5. Wait for the vibration caused by releasing the shutter to diminish. Also, wait for a moment of good seeing.
6. Remove the black card from in front of the telescope for the duration of the exposure (see accompanying table).
7. Replace the black card over the front of the telescope.
8. Close the camera's shutter.

Advance the film and you are ready for your next exposure. Don't forget to take photos of varying duration and keep accurate records of what you have done. Record the date, telescope, exposure duration, eyepiece, f/ratio, film, and some comments on the seeing conditions.

The following table lists exposures for eyepiece projection with a 10mm eyepiece. All exposure times are listed in seconds or fractions of a second.

| Planet  | ISO 50 | ISO 100 | ISO 200 | ISO 400 |
|---------|--------|---------|---------|---------|
| Moon    | 4      | 2       | 1       | 1/2     |
| Mercury | 16     | 8       | 4       | 2       |
| Venus   | 1/2    | 1/4     | 1/8     | 1/15    |
| Mars    | 16     | 8       | 4       | 2       |
| Jupiter | 8      | 4       | 2       | 1       |
| Saturn  | 16     | 8       | 4       | 2       |

**Table 9-2**

The exposure times listed here should be used as a starting point. Always make exposures that are longer and shorter than the recommended time. Also, take a few photos at each shutter speed. This will ensure that you get a good photo. It is not uncommon to go through an entire roll of 36 exposures and have only one good shot.

**NOTE:** Don't expect to record more detail than you can see visually in the eyepiece at the time you are photographing.

Once you have mastered the technique, experiment with different films, different focal length eyepieces, and even different filters.

### ***Effective Focal Length***

---

The effective focal length of the optical system for eyepiece projection is given by this formula:

$$E.F.L. = \text{Magnification} \times DF$$

where *DF* is the distance from the center of the eyepiece to the film and magnification is the focal length of the telescope divided by the focal length of the eyepiece.

### ***Effective Magnification***

---

To determine the magnification when using eyepiece projection, use the equation

$$E.M. = E.F.L. / 50$$

where *E.F.L.* is the effective focal length, in millimeters and *E.M.* is the effective magnification.

## Effective f# or f-ratio

The effective f# can be found by this equation:

$$E.F.\# = E.F.L / D_p$$

where *E.F.L.* is the effective focal length, *D<sub>p</sub>* is the diameter of the primary mirror and *E.F.#* is the effective f-ratio. Make sure you are consistent with units. Use millimeters or inches, not both.

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## Long Exposure Prime Focus Photography

This is the last form of celestial photography to be attempted after others have been mastered. The telescope must be polar aligned on a wedge. It is intended primarily for deep sky objects, that is objects outside our solar system which includes star clusters, nebulae, and galaxies. While it may seem that high magnification is required for these objects, just the opposite is true. Most of these objects cover large angular areas and fit nicely into the prime focus field of your Celestron Telescope. The brightness of these objects, however, requires long exposure times and, as a result, are rather difficult.

There are several techniques for this type of photography, and the one chosen will determine the standard accessories needed. If, for example, you use a separate guidescope, the camera attaches to the telescope with a T-Adapter (#93633-A) and a T-Ring for your specific camera. However, the best method for long exposure deep sky astrophotography is with an off-axis guider. This device allows you to photograph and guide through the telescope simultaneously. Celestron offers a very special and advanced off-axis guider, called the Radial Guider (#94176). In addition, you will need a T-Ring to attach your camera to the Radial Guider.

Other equipment needs include a guiding eyepiece. Unlike piggyback photography which allows for fairly loose guiding, prime focus requires meticulous guiding for long periods. To accomplish this you need a guiding ocular with an illuminated reticle to monitor your guide star. For this purpose, Celestron offers the Micro Guide Eyepiece (#94171). Here are the accessories needed to do long exposure, deep sky photography.

|                    |                                  |          |
|--------------------|----------------------------------|----------|
| • Telescope        | • T-Ring (for your camera brand) | • Wedge  |
| • Radial Guider    | • 35mm Camera                    | • Tripod |
| • Guiding Eyepiece | • Cable Release                  |          |

Here is a brief summary of the technique.

1. Polar align the telescope using the declination drift method.
2. Remove all visual accessories.
3. Thread the Radial Guider onto your Celestron Ultima 2000.
4. Thread the T-Ring onto the Radial Guider.
5. Mount your camera body onto the T-Ring the same as you would any other lens.
6. Set the shutter speed to the "B" setting.
7. Focus the telescope on a star.
8. Center your subject in the field of your camera.

9. Insert an illuminated reticle eyepiece into the radial guider.
10. Find a suitable guide star in the telescope field. Do this by rotating the guider and adjusting the prism. This can be the most time consuming process.
11. Open the shutter using a cable release.
12. Monitor your guide star for the duration of the exposure using the buttons on the hand controller to make the needed corrections. Don't forget to use the PEC function.
13. Close the camera's shutter.

When getting started, use fast films to record as much detail in the shortest possible time. Here are proven recommendations:

- Ektar 1000 (color print)
- Konica 3200 (color print)
- Fujichrome 1600D (color slide)
- T-Max 3200 (black and white print)
- T-Max 400 (black and white print)
- 3M 1000 (color slide)

As you perfect your technique, try specialized films, that is films that are designed or specially treated for celestial photography. Here are some popular choices:

- Ektar 125 (color print)
- Fujichrome 100D (color slide)
- Tech Pan, gas hypered (black and white print)
- T-Max 400 (black and white print)

There is no exposure determination table to help you get started. The best way to determine exposure length is look at previously published photos to see what film/exposure combinations were used. Or take unguided sample photos of various parts of the sky while the drive is running. Always take exposures of various lengths to determine the best exposure time.

## CCD IMAGING

### *Fastar Lens Assembly Option -- Using your Ultima 2000 telescope at f/1.95 with optional PixCel CCD Camera*

Your Ultima 2000 telescope is equipped with a removable secondary mirror that allows you to convert your f/10 telescope into an f/1.95 imaging system capable of exposure times 25 times shorter than those needed with a f/10 system! Used with Celestron's PixCel CCD System, objects will be easily found due to the ultra-wide 2/3° by 1/2° field of view provided. With the optional Fastar lens assembly you can easily convert your Fastar compatible telescope to f/1.95 prime focus use in a matter of seconds. Your telescope can now be used in many different f-number's for CCD imaging. It can be used at f/1.95 (with optional Fastar Lens Assembly), f/6.3 (with the optional reducer corrector), f/10, and f/20 (with the optional 2x barlow) making it one of the most versatile imaging systems available today. This makes the system ideal for imaging deep sky objects as well as planetary detail. The key to the Fastar's versatility is the variety of different F-numbers in which it can be used. Described below is the significance of each F-number and the type of object best suited to that kind of imaging.

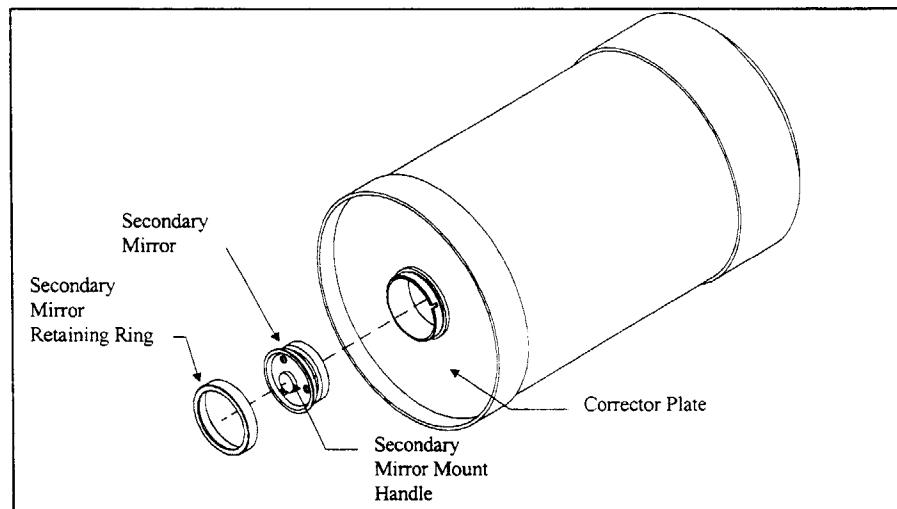
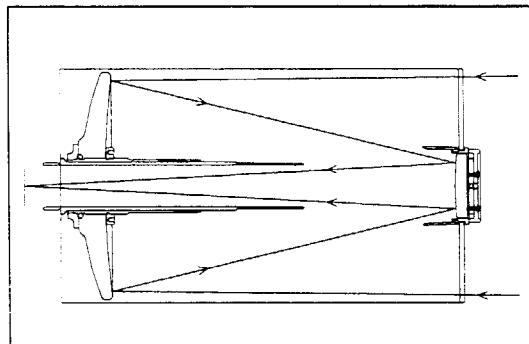


Figure 9-2

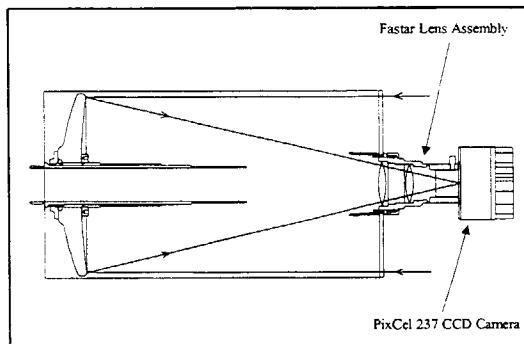
The above figure shows how the secondary mirror is removed when using the optional PixCel CCD camera at f/1.95 and the Fastar lens assembly. **Warning: The secondary mirror should never be removed unless installing the optional Fastar lens assembly.** Adjustments to collimation can easily be made by turning the screws on the top of the secondary mirror mount without ever having to remove the secondary mirror (see Telescope Maintenance section of this manual).

## Description of F-numbers

The F/# stands for the ratio between the focal length and the diameter of the light gathering element. A standard C8 has a focal length of 80 inches and a diameter of 8 inches. This makes the system an f/10, (focal length divided by diameter). When the secondary is removed and the CCD is placed at the Fastar position, the system becomes f/1.95, this is unique to Celestron telescopes (see figures below).



• Fig 9-3 -- Light path at f/10 focus



• Fig 9-4 -- Light path at Fastar f/1.95 focus

The key factors for good CCD imaging are; exposure time, field-of-view, image size, and pixel resolution. As the F/# goes down (or gets faster), the exposure times needed decreases, the field-of-view-increases, but the image scale of the object gets smaller. What is the difference between f/1.95 and f/10? F/1.95 has 1/5 the focal length of f/10. That makes the exposure time needed about 25 times shorter than at f/10, the field of view 5 times larger and the object size 1/5 compared to that of f/10. (see Table 9-3)

|                                 | Standard Cassegrain | With Reducer/corrector Accessory | <b>With Fastar lens Accessory</b>                      |
|---------------------------------|---------------------|----------------------------------|--|
| Focal Length & Speed            | 80" (2000mm) @f/10  | 50" (1250mm) @f/6.3              | <b>16"(400mm) @ f/1.95</b>                             |
| PixCel 237 F.O.V.               | 8.1 x 6.3 (arc min) | 13 x 10 (arc min)                | <b>.69 x .53 (degrees)</b><br><b>41 x 31 (arc min)</b> |
| PixCel Sampling (arc sec/pixel) | .75 (arc sec)       | 1.2 (arc sec)                    | <b>3.8 (arc sec)</b>                                   |

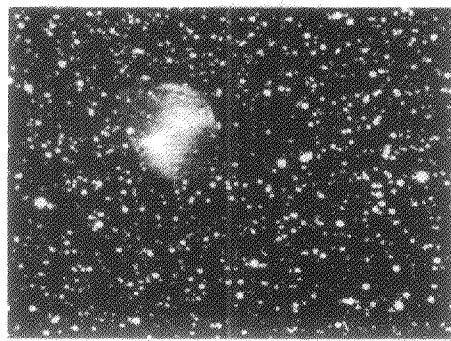
Table 9-3

## Fastar Configurations

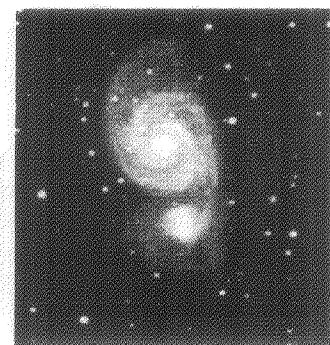
The following is a brief description of the advantages of imaging at each f-number configuration and the proper equipment needed to use the telescope in any of its many settings. Refer to Figure 9-7 for a more detailed description of the accessories offered for each configuration.

### Imaging at f/1.95

As stated above, the exposure times are much shorter at f/1.95 than at f/6.3 or f/10. The field-of-view is wider, so it is easier to find and center objects. Also with a wider field-of-view you can fit larger object (such as M51, The Whirlpool Galaxy) in the frame. Typical exposure times can be 20-30 seconds for many objects. With the Track and Accumulate function on the PixCel software (see the PixCel Operating Manual for more details about its software features), the camera can shoot and stack several images automatically without ever having to guide the exposure. Under dark skies you can get an excellent image of the Dumbbell Nebula (M27) with only a few 30 second exposures (see figure 9-5 below). The spiral arms of the Whirlpool galaxy (Figure 9-6) can be captured with a 30 second exposure and can be improved upon dramatically if several 30-60 second exposures are added together using the Track and Accumulate feature.



**Figure 9-5** M27 – The Dumbbell Nebula  
4 exposures at 30 seconds each!



**Figure 9-6** M51 – The Whirlpool Nebula  
9 exposures at 60 seconds each.

When imaging some objects like planetary nebula (for example M57, the Ring Nebula) and small galaxies (M104, the Sombrero Galaxy), larger image scale is needed to resolve finer detail. These objects are better shot at f/6.3 or even f/10.

### Imaging at f/6.3 (Medium size to small galaxies)

F/6.3 imaging gives you finer resolution than at f/1.95, but the slower f-number will usually require you to guide the image while you are taking longer exposures. Guiding can be accomplished by using an optional Radial Guider or a piggyback guidescope. The exposure times are about 10 times longer but the results can be worth the extra effort. There are some objects that are small enough and bright enough that they work great at f/6.3. M104 (the Sombrero Galaxy) can be imaged under dark skies with a series of short exposures using Track and Accumulate. Ten exposures at 15 seconds each will yield a nice image and is

short enough that you may not need to guide the exposure at all. For f/6.3 imaging the optional f/6.3 Reducer/Corrector is needed. (see Optional Accessory section at the end of this manual).

#### ***Imaging at f/10 (Lunar or small planetary nebulae)***

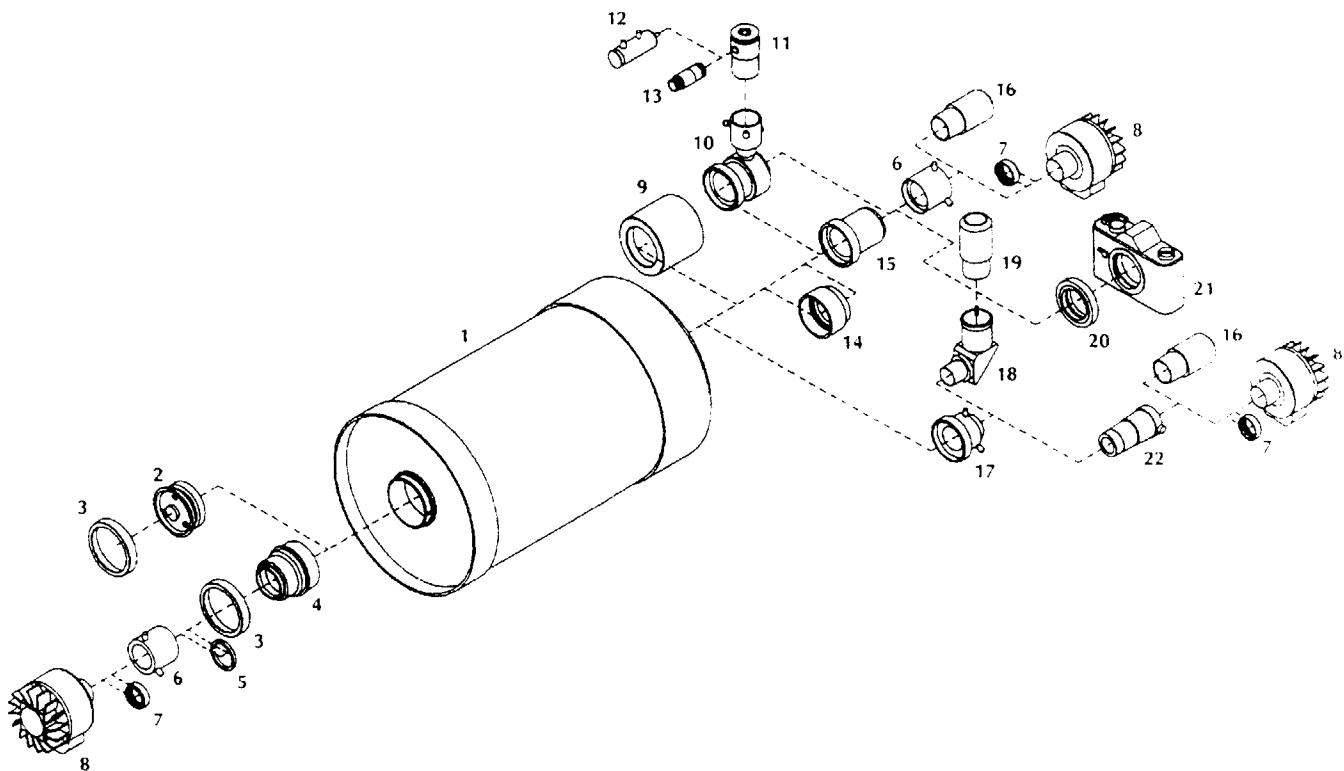
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f/10 imaging is more challenging for long exposure, deep sky imaging. Guiding needs to be very accurate and the exposure times need to be much longer, about 25 times longer than f/1.95. There are only a select few objects that work well at f/10. The moon images fine because it is so bright, but planets are still a bit small and should be shot at f/20. The Ring nebula is a good candidate because it is small and bright. The Ring Nebula (M57) can be imaged in about 30-50 seconds at f/10. The longer the exposure the better.

#### ***Imaging at f/20 (Planetary or lunar)***

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f/20 is a great way to image the planets and features on the moon. With the PixCel CCD camera and optional Color Filter Wheel, it is easy to take tri-color images of planets also. When imaging the planets, very short exposures are needed. Many cameras have trouble taking images under .1 seconds. The PixCel camera can image at .01 seconds exposures due to the design of the CCD array. The exposure lengths range from .03 to .1 seconds on planetary images. Focus is critical as is good atmospheric conditions. Generally you will take one image after another until one looks good (see AutoGrab feature in the PixCel Operating Manual). This is do to the atmospheric "seeing" conditions. For every 10 exposures you might save 1. To image at f/20 you need to purchase a 2x Barlow and a T-adapter or Radial Guider.



**Figure 9-7 - Accessory Configurations for Fastar Compatible Telescopes**

|    |  |    |  |
|----|--|----|--|
| 1  | Optical Tube Assembly                        | 12 | Pulstar Illuminator                    |
| 2  | Secondary Mirror                             | 13 | Illuminator (Microguide Eyepiece only) |
| 3  | Secondary Mirror Retaining Ring              | 14 | Reducer/Corrector f/6.3                |
| 4  | Fastar Lens Assembly                         | 15 | T-Adapter                              |
| 5  | Tricolor Spacer Ring                         | 16 | Cross Hair Eyepiece                    |
| 6  | T-1 1/4" Adapter                             | 17 | Visual Back 1 1/4"                     |
| 7  | IR Cutoff Filter (for use with Color Filter) | 18 | Star Diagonal                          |
| 8  | PixCel CCD Camera                            | 19 | 26mm Plossl Eyepiece                   |
| 9  | Rear Cell Counterweight                      | 20 | T-Ring (for 35mm SLR Camera)           |
| 10 | Radial Guider                                | 21 | 35mm SLR Camera                        |
| 11 | Microguide Eyepiece                          | 22 | 2X Barlow Lens                         |

For more information about the above accessories refer to the Optional Accessories section at the end of this manual



## **MAINTAINING YOUR TELESCOPE PERFORMANCE**

While your Ultima 2000 telescope requires little maintenance, there are a few things to remember that will ensure your telescope performs optimally.

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### **Care and Cleaning of the Optics**

Occasionally, dust and/or moisture may build up on the corrector plate of your Ultima telescope. Special care should be taken when cleaning any instrument so as not to damage the optics.

If dust builds up on the corrector plate, remove it with a brush (made of camel's hair) or a can of pressurized air. When using pressurized air, spray at an angle to the corrector for approximately two to four seconds. Then, use an optical cleaning solution and white, unscented (Kleenex type) tissue paper to remove any remaining debris. Apply the solution to the tissue and then apply the tissue paper to the lens. Low pressure strokes should go from the center of the corrector to the outer edge. Do NOT rub in circles!

You can use a commercially made lens cleaner or mix your own. A good cleaning solution is isopropyl alcohol mixed with distilled water. The solution should be 60% isopropyl alcohol and 40% distilled water. Or, liquid dish soap diluted with water (a couple of drops per one quart of water) can be used.

Occasionally, you may experience dew build-up on the corrector plate of your telescope during an observing session. If you want to continue observing, the dew must be removed, either with a hair dryer or by pointing the telescope at the ground until the dew has evaporated.

If moisture condenses on the inside of the corrector, place the telescope in a dust-free environment. Remove the accessories from the rear cell and point the telescope down. This will remove the moisture from the telescope tube.

To minimize the need to clean your telescope, replace all lens covers once you have finished using it. Since the rear cell is NOT sealed, the cover should be placed over the opening when not in use. This prevents contaminants from entering the optical tube.

Internal adjustments and cleaning should be done only by the Celestron repair department. If your telescope is in need of internal cleaning, please call the factory for a return authorization number and price quote.

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### **Collimation**

The optical performance of your Celestron telescope is directly related to its collimation, the alignment of its optical system. Your Celestron Ultima 2000 was collimated at the factory after it was completely assembled. However, if the telescope is dropped or jarred severely during transport, it may have to be collimated. The only optical element that may need to be adjusted, or is possible, is the tilt of the secondary mirror.

Collimation is the alignment of the optical elements. In the Schmidt-Cassegrain optical system used in the Ultima, this is the alignment of the primary and secondary mirrors.



**Figure 10-1** A collimation pattern (left) of a slightly out of focus star shows concentric rings. An example of an out of collimation system (right) is shown by non symmetric rings that flare out to one side.

To check the collimation of your telescope you will need a light source. A bright star near the zenith is ideal since there is a minimal amount of atmospheric distortion. Turn your telescope drive on so that you won't have to manually track the star. If you are not using the clock drive, use Polaris. It's position relative to the celestial pole means that it moves very little thus eliminating the need to manually track it.

Before you begin the collimation process, be sure that your telescope is in thermal equilibrium with the surroundings. Allow 45 minutes for the telescope to reach equilibrium if you move it between large temperature extremes.

To verify collimation, view a star near the zenith. Use a medium to high power ocular—12mm to 6mm focal length. It is important to center a star in the center of the field to judge collimation. Slowly cross in and out of focus and judge the symmetry of the star. If you see a systematic skewing of the star to one side, then re-collimation is needed.

To accomplish this, you need to locate the secondary alignment screws which are located on the secondary mirror housing. The secondary mirror housing is mounted in the center of the corrector plate. On most models it will be necessary to remove the cap which covers the three secondary alignment screws. The cap just snaps off. You need to tighten the secondary collimation screw(s) that move the star across the field toward the direction of the skewed light. These screws are located in the secondary mirror holder. Make only a small 1/6 to 1/8 field correction and re-center the star by moving the scope before making any improvements or before making further adjustments.

When using higher power, 6mm and above, collimation is best accomplished with the telescope in focus. In this instance, you are observing the Airy disk (see Figure 10-1), not the shadow of the secondary housing. This (stellar) image will appear as a bright point of light with a diffraction ring around it. When the point of light is perfectly centered within the diffraction ring, your telescope is in collimation. Keep in mind that to use high power, the seeing conditions must be very good.

Perfect collimation will yield a star or planetary image very symmetrical just inside and outside of focus. In addition, perfect collimation delivers the optimal optical performance specifications that your telescope is built to achieve.

If seeing (i.e., air steadiness) is turbulent, collimation is difficult to judge. Wait until a better night if it is turbulent or aim to a steadier part of the sky. A steadier part of the sky is judged by steady versus twinkling stars.

**THE ADJUSTMENT SCREWS ON THE SECONDARY MIRROR ARE VERY SENSITIVE.  
USUALLY A TENTH OF A TURN WILL COMPLETELY CHANGE THE COLLIMATION OF THE TELESCOPE. DO NOT FORCE THESE SCREWS IF THEY WILL NOT TURN. IF TIGHTENING ONE SCREW IN THE DIRECTION YOU NEED TO GO IS DIFFICULT, SIMPLY LOOSEN THE OTHER TWO SCREWS BY EQUAL AMOUNTS TO BRING ABOUT THE SAME CHANGE. DO NOT BE INTIMIDATED TO TOUCH UP COLLIMATION AS NEEDED TO ACHIEVE OPTIMAL HIGH-RESOLUTION VIEWS. IT IS WORTH THE TROUBLE!!!!**



The following is a partial list of optional accessories that can be used with your Ultima 2000 telescope:

**AC Adapter - 110V - 60Hz (#18770)** - The AC Adapter allows you to run your Ultima 2000 telescope off of AC rather than the standard DC batteries.

**Accessory Case (#93500)** - This rugged ABS plastic case is designed for carrying a few accessories. Inside is foam padding that is die cut to 1 x 1 inch squares. These squares can be removed to accommodate accessories with a custom fit.

**Barlow Lenses** - A Barlow lens is a negative lens that increases the focal length of a telescope. Used with any eyepiece, it doubles the magnification of that eyepiece. Celestron offers two Barlow lenses in the 1-1/4" size. The 2x Ultima Barlow (#93506) is a compact triplet design that is fully multicoated for maximum light transmission and parfocal when used with the Ultima eyepieces. It works very well with all Celestron eyepieces. The latest Barlow to be added to Celestron's product line (#93507) is a low profile achromatic design at an economical price. It weighs just 4 oz. and it is under 3" in length.

**Car Battery Adapter (#18769)** - To save the internal battery, Celestron offers the Car Battery Adapter which allows you to run the Ultima 2000 off an external 12 VDC power source. The adapter attaches to the cigarette lighter plug of your car.

**Collimated Barlow Diagonal-90°-1 $\frac{1}{4}$ " (#94117)** - An ultra compact 90° barlow diagonal. It contains an integral 1.7X large aperture multi-coated achromatic Barlow lens. The diagonal is laser aligned for rotating centration. Ideal for centering of CCD objects and critical setting circle use.

**Counterweight Set (#94190)**- Using this counterweight set with the standard counterpoise system that comes with the Ultima 2000 allows you to dynamically balance the telescope with heavier accessories.

**Diagonal, Erect Image (#94112-A)** - For daytime terrestrial viewing the Erect Image Diagonal produces images through your Schmidt-Cassegrain telescope that match what you see with the unaided eye. This accessory uses an Amici prism arrangement that, in addition to producing correctly oriented images, allows you to look into the telescope at a 45° angle, a desirable arrangement for terrestrial viewing.

**Eyepiece Filters** - To enhance your visual observations of planetary objects, Celestron offers a wide range of colored filters that thread into the 1-1/4" oculars. Available are: #12 Deep Yellow, #21 Orange, #25 Red, #58 Green, #80A Light Blue, #96 Neutral Density (25% T and 13% T) and Polarizing filters. These filters are also available in sets.

**Eyepieces** - Like telescopes, eyepieces come in a variety of designs. And, with the advent of different eyepieces, Celestron also has a variety of designs each with its own advantages and disadvantages. For the 1-1 /4" barrel diameter there are four different eyepiece designs available.

- **SMA** - Super Modified Achromat. Good quality at an economical price. Models available are a 25mm, 12mm, 10mm and a 6mm.
- **Plossl** - Plossl eyepieces have a 4-element lens system designed for low-to-high power observing. The Plossls offer razor sharp views across the entire field, even at the edges! In the 1-1 /4" barrel diameter, they are available in the following focal lengths: 6.3mm, 7.5mm, 10mm, 12.5mm, 17mm, 20mm, 26mm, 32mm, and 40mm.
- **Ultima** - Ultima is not really a design, but a trade name for our 5-element, wide field eyepieces. In the 1-1/4" barrel diameter, they are available in the following focal lengths: 5mm, 7.5mm, 12.5mm, 18mm, 24mm, 30mm, 35mm, and 42mm. These eyepieces are all parfocal. The 35mm Ultima gives the widest possible field of view with a 1-1 /4" diagonal and is ideal for use with or without the Reducer/Corrector.
- **Lanthanum Eyepieces (LV Series)** - Lanthanum is a unique rare earth glass used in one of the field lenses of this new eyepiece. The Lanthanum glass reduces aberrations to a minimum. All are fully multicoated and have an astounding 20mm of eye relief—perfect for eyeglass wearers! In the 1-1/4" barrel diameter, they are available in the following focal lengths: 2.5mm, 4mm, 5mm, 6mm, 9mm, 10mm, 12mm, 15mm. and a 8-24mm zoom.

In addition to the previously mentioned eyepieces, there is also a deluxe compact zoom ocular (#93306) that has a variable focal length of 6.5 to 18mm. This provides 113 to 313 power on this telescope.

**Fastar Lens Assembly** – Allows you to convert your f/10 Fastar compatible telescope into a f/1.95 imaging system capable of exposure times 25 times shorter than at f/10.

**Flashlight, Red Astro Lite (93590)** - A disposable red flashlight with a removable red filter. This can be used as a red light for astronomy or as a regular flashlight. Just squeeze to operate. This includes a key chain for convenient carrying.

**Flashlight, Night Vision (93588)** - This is a premium red LED flashlight for astronomy. Double LED's allow brightness adjustment to suit your needs. This is bright enough for evening walks or dim enough for map reading with dark adapted eyes. It comes with a lanyard to carry around your neck or on your wrist.

**Flashlight (#93592)** - The LED flashlight uses a red LED to allow reading star maps without ruining your night vision. The LED flashlight is small, only 6 inches long, and weighs in at a mere 3 ounces.

**Focus Motor (#94143)** - For high power observations of planets and/or any objects, a focus motor is a necessity. The focus motor allows for focusing an object without having to touch the telescope. This eliminates unwanted vibrations.

**Light Pollution Reduction (LPR) Filters** - These filters are designed to enhance your views of deep-sky astronomical objects when viewed from urban areas. LPR Filters selectively reduce the transmission of certain wavelengths of light, specifically those produced by artificial lights. This includes mercury and high and low pressure sodium vapor lights. In addition, they also block unwanted natural light (sky glow) caused by neutral oxygen emission in our atmosphere. Celestron offers a model for 1-1/4" eyepieces (#94126A) and a model that attaches to the rear cell ahead of the star diagonal and visual back (#94127A)

**Lens Shade (#94019)** - The Dew Cap/Lens shade is a tube that fits on the front end of the telescope to reduce the amount of dew that builds up on the corrector plate when observing at night. For daytime observing, this accessory works as a lens shade to prevent stray light from falling on the corrector, a situation which reduces contrast. Day or night, the Dew Cap/Lens Shade will enhance all your views.

**Micro Guide Eyepiece(#94171)** - This multipurpose illuminated 12.5mm reticle can be used for guiding deep-sky astrophotos, measuring position angles, angular separations, and more. The laser etched reticle provides razor sharp lines and the variable brightness illuminator is completely cordless. The Micro Guide eyepiece produces 163 power when used with this telescope.

**Piggyback Mount (#93598)** - The best way to enter the realm of deep-sky photography is via the piggyback method. Piggyback photography allows you to record constellations and large scale nebulae that don't fit in the field of your telescope. The piggyback mount allows you to attach a camera to the top of the telescope. This way, the camera can photograph with its normal or wide angle lens while you guide through the telescope. The piggyback mount attaches to the rear cell of the telescope next to the finder.

**Planisphere (#93720-30/40/50)** - A rotating star map which indicates when specific constellations are visible. It also has removable markers for tracking the movements of solar system objects. There are models for three different latitudes; 30°, 40°, and 50°.

**Polarizing Filter Set (#93608)** - The polarizing filter set limits the transmission of light to a specific plane, thus increasing contrast between various objects. This is used primarily for terrestrial, lunar, and planetary observing.

**Quick Release Finder Bracket (#51149-A)** - This finder bracket allows you to remove and protect the finderscope (50mm) from the telescope tube and yet maintain the alignment of the finder to the main telescope.

**Radial Guider (#94176)** - The Celestron Radial Guider is specifically designed for use in prime focus, deep-sky astrophotography as well as CCD imaging and takes the place of the T-Adapter. This device allows you to photograph and guide simultaneously through the optical tube assembly of your telescope. This type of guiding produces the best results since what you see through the guiding eyepiece is exactly reproduced on the processed film. The Radial guider is a "T"-shaped assembly that attaches to the rear cell of the telescope. As light from the telescope enters the guider, most passes straight through to the camera. A small portion, however, is diverted by a prism at an adjustable angle up to the guiding eyepiece. This guider has two features not found on other off-axis guiders; first, the prism and eyepiece housing rotate independently of the camera orientation making the acquisition of a guide star quite easy. Second, the prism angle is tunable allowing you to look at guide stars on-axis. This accessory works especially well with the Reducer/Corrector (#94175).

**Reducer/Corrector (#94175)** - This lens reduces the focal length of the telescope by 37%, making your Ultima-2000 a 1280mm f/6.3 instrument. In addition, this unique lens also corrects inherent aberrations to produce crisp images all the way across the field. It also increases the field of view significantly and is ideal for wide-field, deep-sky viewing. It is perfect for beginning prime focus long-exposure astrophotography. It makes guiding easier and exposures shorter. It is also a necessity for CCD imaging.

**Sky Maps (#93722)** - When learning the night sky, the Celestron Sky Maps offer the ideal solution. The maps include all the constellations and brighter deep-sky objects. The maps are printed on a heavy stock paper that is moisture-resistant. On the front cover is a rotating planisphere which indicates when specific constellations are visible.

**Skylight Filter (#93621)** - The Skylight Filter is used on Celestron Schmidt-Cassegrain telescopes as a dust seal. The filter threads onto the rear cell of your telescope. All other accessories, both visual and photographic, thread onto the Skylight Filter. Although it does cut down on a portion of the incoming light, it is a very small amount. It should be noted, that most Barlow lenses can NOT be inserted into the visual back when the skylight filter is attached.

**Solar Filter (#94162)** - The Celestron Solar Skreen® solar filter permits direct observation of the Sun in complete safety. This filter, which transmits .001% of visible light, allows you to see sunspots as they move across the solar disk. In addition to reducing the intensity of the Sun's visible light, it also blocks 99.999% of invisible infrared light. The Celestron Solar Skreen solar filter is made of precision engineered Mylar polyester film. A layer of aluminum is vacuum-deposited on one surface of the dual sheets of Mylar used to make each filter. The aluminum coating produces a cool, comfortable pale blue image of the Sun. (A #21 orange eyepiece filter works well in conjunction with this filter to produce a more natural color Sun). This filter can be used for visual observation and photography.

**NEVER LOOK DIRECTLY AT THE SUN WITH THE NAKED EYE OR WITH A TELESCOPE. NEVER POINT YOUR TELESCOPE AT THE SUN UNLESS YOU HAVE THE PROPER FILTER.**

**Star Diagonal - 2" (#93519)** - The 2" mirror Star Diagonal allows you to use 2" eyepieces with your Celestron telescope. These larger eyepieces offer wider fields and better eye relief for greater viewing comfort. **This accessory is NOT recommended for use with the Reducer/Corrector Lens.**

**Star Pointer (#51630)** - This accessory is used to aim a telescope at a visible object very quickly. This projects a point of light onto a clear screen which allows you to see the object and point simultaneously. To aim the telescope at an object, just line up the object and the projected point of light. The Star Pointer is powered by a 3-volt lithium battery (included). It is super compact and light weight - 4.5" long and only 1.5 oz. Mounts easily with double sided adhesive to your telescope and has a quick release from its base. Extra mounting bases are available for use with additional telescopes.

**T-Adapter (#93633-A)** - A T-Adapter (with T-Ring) allows you to attach your camera to the prime focus of a Celestron Schmidt-Cassegrain telescope. This is used for terrestrial photography and short exposure lunar and filtered solar photography. It can be used for long exposure deep-sky photography if you use a separate guide-scope.

**T-C Adapter (#93636)** - This adapter allows you to couple a video or movie camera to a telescope. The camera must have a removable lens with a standard "C" thread. The T-C adapter threads into the camera and then onto the T-Adapter.

**T-Ring** - The T-Ring couples your camera body to the T-Adapter, Radial Guider Body, or Tele-Extender. This accessory is mandatory if you want to do astrophotography through the telescope. Each camera make (i.e., Minolta, Nikon, etc.) has its own unique mount and therefore, its own T-Ring.

**Tele-Extender, Deluxe (#93643)** - The tele-extender is a hollow tube that allows you to attach a camera to the telescope when the eyepiece is installed. This accessory is used for eyepiece projection photography which allows you to capture very high power views of the Sun, Moon, and planets on film. The tele-extender fits over the eyepiece onto the visual back and works with eyepieces that have large housings, like the Celestron Ultima series.

**Vibration Suppression Pads (#93503)** - These pads reduce the amplitude and vibration time of your telescope when shaken by the wind or an accidental bump. They rest between the ground and tripod feet of your telescope. VSPs are recommended for all observing conditions.

**Wedge (#93655)** - This heavy duty wedge is used to Polar Align the Ultima 2000 so it can be used for long exposure CCD imaging or astrophotography.

**Wedge Upgrade Kit (#93662)** - This kit upgrades the wedge so that no tools are necessary to attach the wedge to the tripod and to attach the telescope to the wedge. This kit also allows you to fine adjust the latitude and azimuth of the wedge for polar alignment purposes.

A full description of all Celestron accessories can be found in the **Celestron Accessory Catalog (#93685)**.

**Alignment Star List**

| Name           | Greek | Constellation | h m s      | deg min sec | V    | Type     |
|----------------|-------|---------------|------------|-------------|------|----------|
| Achernar       | alpha | Eri           | 1 37 42.9  | -57 14 12   | 0.5  | star     |
| Albireo        | beta  | Cyg           | 19 30 43.1 | 27 57 35    | 3.1  | dbl      |
| Aldebaran      | alpha | Tau           | 4 35 55.2  | 16 30 33    | 0.9  | col      |
| Alphard        | alpha | Hya           | 9 27 35.2  | -8 39 31    | 2.0  | dbl red  |
| Alpha Centauri | alpha | Cen           | 14 39 36.7 | -60 50 02   | 0.0  | star     |
| Alpheratz      | alpha | And           | 0 08 23.2  | 29 05 26    | 2.1  | dbl      |
| Altair         | alpha | Aql           | 19 50 46.8 | 8 52 06     | 0.8  | star     |
| Antares        | alpha | Sco           | 16 29 24.3 | -26 25 5    | 1.0  | star     |
| Arcturus       | alpha | Boo           | 14 15 39.6 | 19 10 57    | 0.0  | dbl red  |
| Betelgeuse     | alpha | Ori           | 5 55 10.2  | 7 24 26     | 0.1  | star red |
| Canopus        | alpha | Car           | 62 35 7.1  | -52 41 44   | -0.7 | star     |
| Capella        | alpha | Aur           | 5 16 41.3  | 45 59 53    | 0.1  | star     |
| Castor         | alpha | Gem           | 7 34 35.9  | 31 53 18    | 1.6  | dbl      |
| Deneb          | alpha | Cyg           | 20 41 25.8 | 45 16 49    | 1.3  | star     |
| Denebola       | beta  | Leo           | 11 49 03.5 | 14 34 19    | 2.1  | dbl col  |
| Fomalhaut      | alpha | PsA           | 22 57 38.9 | -29 37 20   | 1.2  | star     |
| Mirfak         | alpha | Per           | 32 41 9.3  | 49 51 40    | 1.8  | star     |
| Mizar          | zeta  | UMa           | 13 23 55.5 | 54 55 31    | 2.3  | dbl      |
| Navi           | amma  | Cas           | 0 56 42.4  | 60 43 00    | 2.5  | dbl      |
| Polaris        | alpha | UMi           | 2 31 50.4  | 89 15 51    | 2.0  | dbl      |
| Procyon        | alpha | Cmi           | 7 39 18.1  | 5 13 30     | 0.4  | star     |
| Rasalhague     | alpha | Oph           | 17 34 55.9 | 12 33 36    | 2.1  | star     |
| Regulus        | alpha | Leo           | 10 08 22.2 | 11 58 02    | 1.4  | dbl      |
| Rigel          | beta  | Ori           | 5 14 32.2  | -8 12 06    | 0.1  | dbl      |
| Sirius         | alpha | CMa           | 6 45 08.9  | -16 42 58   | -1.5 | dbl      |
| Spica          | alpha | vir           | 13 25 11.5 | -11 09 41   | 1.0  | star     |
| Suhail         | mbda  | Vel           | 9 07 59.7  | -43 25 57   | 2.2  | star     |
| Vega           | alpha | Lyr           | 18 36 56.2 | 38 47 01    | 0.0  | mpl      |

## Constellation Abbreviations

| Abbreviation | Constellation    | Abbreviation | Constellation  | Abbreviation | Constellation |
|--------------|------------------|--------------|----------------|--------------|---------------|
| AND          | Andromeda        | CVN          | Canes Venatici | OPH          | Ophiuchus     |
| ANT          | Antilia          | CYG          | Cygnus         | ORI          | Orion         |
| APS          | Apus             | DEL          | Delphinus      | PAV          | Pavo          |
| AOL          | Aquila           | DOR          | Dorado         | PEG          | Pegasus       |
| AQR          | Aquarius         | DRA          | Draco          | PER          | Perseus       |
| ARA          | Ara              | EQU          | Equuleus       | PHE          | Phoenix       |
| ARI          | Aries            | ERI          | Eridanus       | PIC          | Pictor        |
| AUR          | Auriga           | FOR          | Fomax          | PSC          | Pisces        |
| BOO          | Bootes           | GEM          | Gemini         | PUP          | Puppis        |
| CAE          | Caelum           | GRU          | Grus           | PYX          | Pyxis         |
| CAM          | Camelopardalis   | HER          | Hercules       | RET          | Reticulum     |
| CAP          | Capricornus      | HOR          | Horologium     | SCL          | Sculptor      |
| CAR          | Carina           | HYA          | Hydra          | SCO          | Scorpius      |
| CAS          | Cassiopeia       | HYI          | Hydrus         | SCT          | Scutum        |
| CEN          | Centaurus        | IND          | Indus          | SER          | Serpens       |
| CEP          | Cepheus          | LAC          | Lacerta        | SEX          | Sextans       |
| CET          | Cetus            | LEO          | Leo            | SGE          | Sagitta       |
| CHA          | Chamaeleon       | LEP          | Leprus         | SGR          | Sagittarius   |
| CIR          | Circinus         | LIB          | Libra          | TAU          | Taurus        |
| CMA          | Canis Major      | LMI          | Leo Minor      | TEL          | Telescopium   |
| CMI          | Canis Minor      | LUP          | Lupus          | TRA          | Triangulum    |
| CNC          | Cancer           | LYN          | Lynx           | TRI          | Triangulum    |
| COL          | Columba          | LYR          | Lyra           | TUC          | Tucana        |
| COM          | Corma Berenices  | MEN          | Mensa          | UMA          | Ursa Major    |
| CRA          | Corona Australis | MIC          | Microscopium   | VEL          | Vela          |
| CRB          | Corona Borealis  | MON          | Monoceros      | VIR          | Virgo         |
| CRT          | Crater           | MUS          | Musca          | VOL          | Volans        |
| CRU          | Crux             | NOR          | Morma          | VUL          | Vulpecula     |
| CRV          | Corvus           | OCT          | Octans         |              |               |

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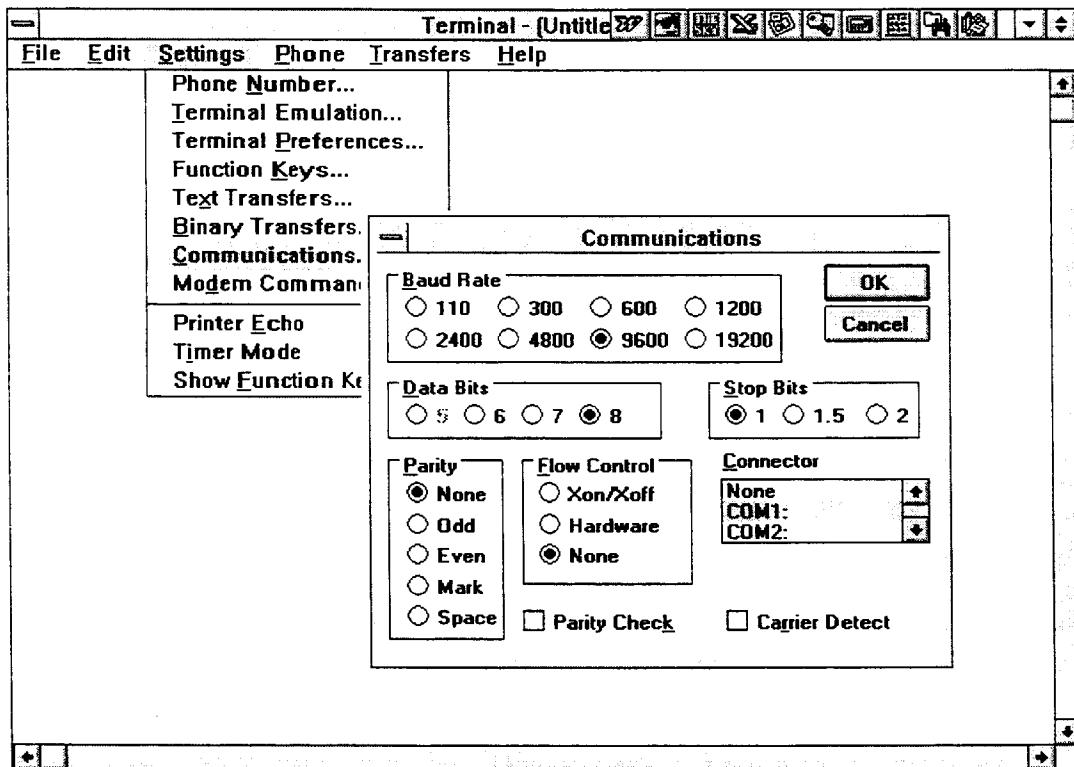
## List of Named Object Catalog

Here is the list of all the objects under the NAMED OBJECTS menu.

| Display  | Common Name                  | Identification | Type             |
|----------|------------------------------|----------------|------------------|
| ANDROMED | Andromeda Galaxy             | M031           | Galaxy           |
| BEEHIVE  | Beehive Cluster              | M044           | Open Cluster     |
| BLACKEYE | Blackeye Galaxy              | M064           | Galaxy           |
| BLINKING | Blinking Planetary           | NGC6826        | Planetary Nebula |
| BUTTERFL | Butterfly Cluster            | M006           | Open Cluster     |
| CATS EYE | Cats Eye                     | NGC6543        | Planetary Nebula |
| CRAB NEB | Crab Nebula                  | M001           | Nebula           |
| DOUBLE C | Double Cluster               | NGC0869        | Open Cluster     |
| DUMBBELL | Dumbbell Nebula              | M027           | Nebula           |
| EAGLE NE | Eagle Nebula                 | M016           | Nebula           |
| ESKIMO N | Eskimo Nebula                | NGC2392        | Nebula           |
| GHOST OF | Ghost of Jupiter             | NGC3242        | Planetary Nebula |
| HELIX NE | Helix Nebula                 | NGC7293        | Planetary Nebula |
| HERCULES | Hercules Cluster             | M013           | Globular Cluster |
| HUBBLES  | Hubbles Variable             | NGC2261        | Nebula           |
| LAGOON N | Lagoon Nebula                | M008           | Nebula           |
| NORTH AM | North American Nebula        | NGC7000        | Nebula           |
| OMEGA CE | Omega Centaurus              | NGC5139        | Globular Cluster |
| ORION NE | Orion Nebula                 | M042           | Nebula           |
| OWL NEBU | Owl Nebula                   | M097           | Planetary Nebula |
| PINWHEEL | Pinwheel Galaxy              | M033           | Galaxy           |
| PLEIADES | Pleiades (The Seven Sisters) | M045           | Open Cluster     |
| RING NEB | Ring Nebula                  | M057           | Planetary Nebula |
| ROSETTE  | Rosette Nebula               | NGC2237        | Nebula           |
| SATURN N | Saturn Nebula                | NGC7009        | Planetary Nebula |
| SOMBRERO | Sombrero Galaxy              | M104           | Galaxy           |
| SUNFLOWE | Sunflower Galaxy             | M063           | Galaxy           |
| OMEGA NE | Omega Nebula (Swan Nebula)   | M017           | Nebula           |
| TRIFID   | Trifid Nebula                | M020           | Nebula           |
| VEIL NEB | Veil Nebula                  | NGC6960        | Nebula           |
| WHIRLPOO | Whirlpool Galaxy             | M051           | Galaxy           |
| WILD DUC | Wild Duck Cluster            | M011           | Open Cluster     |



You can control the Ultima 2000 telescope with a PC. You use Terminal under the Accessories Menu in Windows. The settings needed to allow your computer to communicate to the telescope through Terminal are shown in the figure below. Communication with the telescope is via an RS-232 port running at 9600 baud, 8 data bits, 1 stop bit, no parity, and no flow control.



The cable required to interface to the telescope has an RS-232 male plug at one end and a 6-pin telephone jack at the other end. The wiring is as follows:

- Green wire to pin 2
- Yellow wire to pin 3
- Red wire to pin 7
- Black wire to pin 8.

Depending on the configuration of the serial interface on the PC, it may be necessary to get an RS-232 wiring box and attach male pin 4 to male pin 8 and male pin 6 to male pin 20. The telescope neither monitors nor sets Data Terminal Ready or Data Set Ready. Similarly, for Ready to Send and Clear to Send. What this means is, some computers send 5 volts over a line to tell the device it is trying to communicate with that it is on. These computers would also expect to receive a 5 volt signal coming back to them so they know the device they are trying to communicate with is on. The Ultima 2000 does not send or monitor 5 volt signals. If a PC requires these signals, it is necessary to feed the signals provided by the PC back to the PC.

## Commands

The commands all start with a capital letter indicating the type of request, and then any data necessary for the request. All letters must be upper case.

To activate a command press return. To nullify a command, press the “delete” button on the computer keyboard. So, if you partially type in a command and decide you made a mistake, press “delete” and a new line will appear but the command will not be sent to the telescope.

Here are a list of the commands and their functions.

*Note: All the numbers unless otherwise stated are written in hexadecimal.*

| Command Name    | Description  | PC Command | Return Message                          |
|-----------------|--|------------|---|
| PCALIGN         | “F” is the command followed by the RA and DEC 16-bit angles written in hexadecimal. Use this to perform a star alignment operation. The return message is a warp factor in decimal form.   | F4321,8765 | -23.1#                                  |
| PCCANSLEW       | Cancels a slew that is in progress   | M          | #                                       |
| PCGETTRACK      | These are the current tracking rates for the alt and az axes. The values are in hexadecimal. The displayed value “x” indicates that the telescope is moving at a rate of x/65536 tracking encoder ticks per millisecond. There are eight tracking ticks per tracking motor shaft revolution. | U          | 1234,5678#                              |
| PCCSETTRACK     | Set tracking rate for azimuth axis and tracking for altitude axis. Sidereal tracking rate is about hex 0800. “T” is the command followed by the azimuth and the altitude values.   | T1234,5678 | #                                       |
| PCLOOKUP        | Return database info on current object.  | D          | object name, constel, description, MAG# |
| PCECHO          | This command causes the telescope to return the character it was sent. This command makes it possible for the PC to know that communication between the PC and the telescope is synchronized.  | Kx         | x#                                      |
| PCGOTOALTAZ     | “A” is the command, the relative coordinates follow. Az is first; in this case az is hex 12AB, alt is hex 4000. These are 16-bit angles. These are Alt-Az positions relative to the downstops. They are not actual Alt-Az coordinates.   | A12AB,4000 | #                                       |
| PCGOTOCORRALTAZ | “B” is the command, the relative coordinates follow. Az is first; in this case az is hex 12AB, alt is hex 4000. These are  | B12AB,4000 | #                                       |

|             |  |            |            |
|-------------|--|------------|------------|
|             | 16-bit angles. This command applies the accurization algorithm to the specified coordinates to provide high all-sky pointing accuracy.   |            |            |
| PCGOTOCUR   | Slew the telescope to the current object   | C          | #          |
| PCGOTORADEC | Slew to specified RA/DEC. The command is "R" followed by the RA 16-bit angle (34AB) and the DEC 16-bit angle (12CE)  | R34AB,12CE | #          |
| PCNMLTRACK  | Have the telescope go to alt/az tracking   | N          | #          |
| PCRADEC     | Return the current RA and DEC. RA is first. These are 16-bit angles.   | E          | 34AB,12CE# |
| PCSETALTAZ  | Define wherever the telescope is pointing to by the specified alt and az. This is a potentially dangerous command; the telescope depends on having alt = 0 when the tube is perpendicular to the fork arms. If this is not true it will invalidate the computation of RA and DEC. "S" is the command, followed by the 16-bit positions; az and alt respectively. | S1234,5678 | #          |
| PCSETCUR    | Make the named catalog object the 'current' object. The command is "O" followed by an object in one of the catalog databases. (ex. NGC0001, M001, etc.)  | ONGC4002   | #          |
| PCSLEWQUERY | Query the telescope to see if a slew is currently in progress. A return of 0 indicates no slew and a return of 1 indicates a slew in progress.   | L          | 0# or 1#   |
| PCTELESCOPE | This gives the telescope's relative position. This is the same as TELESCOP under the POSITION menu. The command is "Z" and the return is 16-bit angles, azimuth and altitude respectively.   | Z          | 128E,FFD4  |

## Optical Specifications

|  |   |
|--|---|
| Design   | Schmidt-Cassegrain Catadioptric   |
| Aperture   | 8 inches (203mm)  |
| Focal Length   | 80 inches (2032mm)  |
| F/ratio of the Optical System                                      | 10  |
| Primary Mirror   | Figure:<br>Spherical<br>8 $\frac{1}{4}$ "<br>Diameter:<br>f/ratio:<br>f/1.9<br>Radius of Curvature:<br>32"<br>Material:<br>Fine Annealed Pyrex<br>Coatings:<br>Starbright Coatings - 5 step multilayer process                                  |
| Secondary Mirror   | Figure:<br>Spherical (final hand figuring yields slightly aspheric figure)<br>2 $\frac{1}{4}$ "<br>Diameter:<br>Radius of Curvature:<br>9.7<br>Material:<br>Fine Annealed Pyrex<br>Coatings:<br>Starbright Coatings - 5 step multilayer process |
| Central Obstruction  | 2 $\frac{3}{4}$ "   |
| Corrector Plate  | Figure<br>True aspheric Schmidt curve on one side.<br>Material<br>Optical Quality Crown Glass<br>Thickness<br>.190"<br>Coatings<br>A-R Coatings both sides  |
| Highest Useful Magnification                                       | 480x (~ 4mm eyepiece)   |
| Lowest Useful Magnification (7mm exit pupil)                       | 29x (~ 70mm eyepiece)<br>(~ 44mm eyepiece with optional Reducer Corrector)  |
| Resolution:  |   |
| Rayleigh Criterion   | .68 arc seconds   |
| Dawes Limit  | .57 arc seconds   |
| Photographic Resolution  | 182 lines/mm  |
| Image Scale ( CCD imaging or astrophotography)                     | 100 arcseconds/mm<br>64 arcseconds/mm   |
| Light Gathering Power  | 842x unaided eye  |
| Back Focus   | 18 ± 5 inches   |
| Optimum Back Focus (f/10)<br>with optional f/6.3 Reducer Corrector | ~ 4"<br>~ 4" from outside optical surface of the Reducer Corrector  |
| Near Focus standard eyepiece                                       | ~ 25 feet   |
| Near Focus with Camera   | ~ 25 feet   |
| Field of View  |   |
| with Standard Eyepiece   | .65°  |
| with 35mm Camera   | .99° x .68° (.62° x .43° - with optional Reducer Corrector)   |
| Magnification  |   |
| with Standard Eyepiece   | 78x   |
| with Camera  | 41x   |
| Optical Tube Length  | 16 inches   |
| Optical Tube Diameter  | 9 inches  |
| Front Cell Diameter  | 9 $\frac{1}{8}$ inches  |

## Mechanical Specifications

|  |   |
|--|---|
| AZM Drive System<br>Tracking Motor<br>Slewing Motor                                | 3-speed DC-Servo<br>2-Speed DC  |
| ALT Drive System<br>Tracking Motor<br>Slewing Motor                                | 3-Speed DC-Servo<br>2-Speed DC  |
| AZM Tracking Gear<br>Number of Teeth<br>Type<br>Pitch Diameter<br>Final Gear Ratio | 266 teeth<br>48 pitch - Helical / Worm<br>5.535 inches<br>665,000:1   |
| ALT Tracking Gear<br>Number of Teeth<br>Type<br>Pitch Diameter<br>Final Gear Ratio | 241 teeth<br>48 pitch - Helical / Worm<br>5.021 inches<br>602,500:1   |
| AZM Slewing Gear<br>Number of Teeth<br>Type<br>Pitch Diameter<br>Final Gear Ratio  | 288 teeth<br>48 pitch<br>6.00 inches<br>2000:1  |
| ALT Slewing Gear<br>Number of Teeth<br>Type<br>Pitch Diameter<br>Final Gear Ratio  | 240 teeth<br>48 pitch<br>5.00 inches<br>1663:1  |
| Time for AZM worm to rotate one revolution at sidereal rate.                       | 5.41 minutes <i>This only applies when the telescope is set to EQ NORTH under the TRACKING option within the SETUP menu</i> |
| Altitude Encoder<br>Resolution<br>Enhanced Encoder Resolution (EER)                | 8192 counts per 360°<br>~ 2.5 arc-minutes<br>65536 counts per 360° ~ 19 arc-seconds   |
| Azimuth Encoder<br>Resolution<br>Enhanced Encoder Resolution (EER)                 | 8192 counts per 360°<br>~2.5 arc-minutes<br>65536 counts per 360° ~ 19 arc-seconds  |
| Maximum Weight Capacity  | 25 Lbs.   |
| Weight of Telescope  | 31 Lbs.   |
| Weight of Tripod   | 19 Lbs.   |

*Appendix C - Technical Specifications*

**Shipping Information**

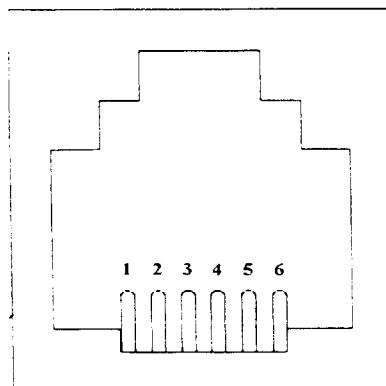
|                     |                 |
|---------------------|-----------------|
| Shipping Dimensions |                 |
| Telescope Box       | 21" x 15" x 30" |
| Tripod Box          | 18" x 16" x 37" |
| Accessory Box       | 12" x 8" x 4"   |
| Shipping Weights    |                 |
| Telescope           | 53 Lbs.         |
| Accessories         | 5 Lbs.          |
| Tripod              | 26 Lbs.         |

**Electronic Specifications**

|                           |                              |
|---------------------------|------------------------------|
| Input Voltage             | 12 VDC Nominal               |
| Maximum                   | 18 VDC Max.                  |
| Minimum                   | 8 VDC Min.                   |
| Batteries Required        | 8 AA Alkaline                |
| Power Supply Requirements | 12 VDC-500 mA (Tip positive) |



For long exposure astrophotography, you can use an auto guider to guide the exposure for you. The telescope should be on the optional wedge and polar aligned. Here is the pin layout for the jack on the drive base labeled GUIDE. Below is a diagram of the jack and pertinent information needed to attach a CCD autoguider.



## **GUIDE**

| <b>Label</b> | <b>Direction</b> | <b>Corresponding Button</b> |
|--------------|------------------|-----------------------------|
| 1            | West             | Right                       |
| 2            | South            | Up                          |
| 3            | North            | Down                        |
| 4            | East             | Left                        |
| 5            | Common           | -                           |
| 6            | Not Used         | -                           |

All the pins are normally open. To get the telescope to guide at photo rate in any particular direction, the autoguider must close the pin that coincides with the direction you need to guide with the common pin. For example, if you need the telescope to guide North, the guider must close the connection between pin 3 (North) and pin 5 (common). If you need the telescope to guide East, the guider must close the connection between pin 4 (North) and 5 (common). Refer to the auto guider's manual to actually connect it to the Ultima 2000.

## APPENDIX E - OPERATIONAL TIPS

### ***Setting the backlash compensations for an auto guider***

---

#### HAND CONTROL RESPONSE

The Ultima 2000 has a unique user programmable anti-backlash feature. Due to the enormous gear reductions required for Alt-Az tracking and also the fact that direction changes are required, a high speed crossover and dead zone centering feature is supplied. Depending upon the amount of backlash compensation desired, an interval of time is required for this to properly occur after a directional button is pressed and released. Upon releasing a button, the tracking motor centers itself, in the dead zone, to offer a shortened response time to the next button movement command. A couple of seconds is usually required for this re-centering. A relaxed (under damped) button response gives best results while guiding (it is best to wait a second or two before pressing a button again). This is true for both human and auto-guiders. For equatorially mounted telescopes, the RA tracking will not require or use the backlash compensation (this is true for photo rate and 2X sidereal) since button corrections never reverse the RA tracking motor. The 6X centering speed uses the backlash compensation since it can reverse during visual acquisition of objects. The declination axis nearly always reverses direction whether in equatorial or Alt-Az , so backlash compensation is important there.

#### AUTO GUIDING

As explained above, the Ultima 2000 requires under damped, relaxed commands to guide with backlash compensation activated. If your auto guider can be adjusted to make corrections about every 5 seconds, this should allow for best results.

### ***Viewing near the zenith in Alt-Az***

---

Altazimuth tracking requires motors on both axis to move at varying rates. The rates are dependent on which part of the sky the telescope is pointed and the latitude of your observing location. If you are observing stars rising in the east, the altitude tracking motor is doing almost all the work. If you are observing near the celestial equator and close to the meridian, then the azimuth motor is doing nearly all the work. Altazimuth tracking becomes extremely difficult at and near the zenith. As the telescope tracks close to the zenith, the azimuth tracking motors must run very fast. As the telescope tracks across the zenith, the azimuth tracking motors need to run infinitely fast. Since this is not possible, the telescope will not track well near the zenith. You will also notice that the azimuth centering speed seems very slow as you get closer to the zenith. This is a normal effect of observing near the zenith with an altazimuth mount. You will not notice these problems if you are using a wedge and polar align the telescope.

### ***The effects of a star diagonal on pointing accuracy***

---

A diagonal can slightly change the optical axis of a telescope. A star that is in the center of the field in an eyepiece can be off center when a diagonal is used. This angular error is known as cone angle. If you center the star in the eyepiece then rotate the diagonal, you will notice the star does not stay in one place. This is because the diagonal mirror is not placed perfectly in its holder (all diagonals are like this except for collimated diagonals). Because of this you need to be aware of how to use a diagonal with a computerized telescope. Let's consider altitude first.

When you place your diagonal in a position (i.e. upright, or to the left 20°, or to the right 45°, etc..) for observing, it introduces some amount of cone angle in the altitude direction. This does not matter unless you rotate the diagonal. When you rotate the diagonal, some component of the altitude cone angle is transferred to azimuth. So when you align the telescope to your alignment stars, don't change the position of the diagonal. If you do change the position while you are observing an object, move the diagonal back to its original position before slewing to the next object. (You only need to worry about this if you are concerned about maximum pointing accuracy. Don't worry about this if you are just observing.)

There is azimuth cone angle introduced by a star diagonal too. But, there is not a way to counter it without using a collimated star diagonal. The cone angle is usually pretty small on the diagonals and the effect of the angle is cut in half if you align to objects between 30° and 60° in altitude. The effect is maximized at the zenith and the horizon.

**The bottom line of diagonal use if pointing accuracy is an issue.**

1. Align stars with the diagonal in one orientation around the optical axis.
2. Use the same orientation of the diagonal to align and to find objects.
3. For the absolute best pointing accuracy, use a laser collimated diagonal in one position only or don't use a diagonal at all.

***Viewing objects below the horizon***

---

The Ultima 2000 does not stop you from slewing the telescope to an object that is below the horizon. On large professional telescopes it can be dangerous for the telescope to slew below the horizon, but there is no danger to the Ultima 2000. Since you can slew below the horizon, you can get a feel for the locations of celestial objects in the sky; even if they are not yet in the sky. The Ultima 2000 can still point to them. If you see the telescope slew just below the horizon to the East, you know the object is going to rise shortly. If you want to illustrate to your friends or yourself how the Earth is rotating, it might be instructive to slew to the Sun at 2:00 AM in the morning. The Ultima 2000 will point to you where the Sun is. You can have a feel of how the stars rise and set and rise again!

***Using Cord Wrap***

---

In the event that the telescope continues to slew in only one direction in azimuth while the Cord Wrap feature is on, you may need to cycle the power OFF, then turn the power ON again. This should return the telescope to slewing in the direction that will keep it from wrapping the powercord around itself. If you are not using an external power source, it is useful to turn the Cord Wrap Control to OFF.

***Slewing Autostop***

---

The Ultima 2000 has an auto stop feature should you need to stop the telescope from slewing. The first way to stop your telescope from slewing is to press any of the diamond buttons on the hand control. The second way is to push the tube slightly in the opposite direction to which it is slewing. This will also abort the slew. One consideration to the second method is that if the telescope is not balanced in altitude, it is possible that when the telescope slews to an object, the telescope may move slightly in the opposite direction which will abort the slew. To fix this either carefully balance the telescope or press the GOTO command again. Another consideration is that from time to time, when the telescope is commanded to slew to an object, it may pass by the object in the final phase of centering. Instead of stopping at the object the motors stay on and the telescope continues pass the object. The telescope has not lost its alignment but has been confused by the abort command and does not successfully abort. When this occurs, press any of the diamond buttons to finally abort the slew, then slew to the object again.



|                           |   |
|---------------------------|---|
| 16-bit                    | This is the resolution of the software of the Ultima 2000. 16-bit resolution gives $2^{16}$ discrete integers for the software to calculate the transformation from RA/DEC to Alt-Az.   |
| Airy Disk                 | The central bright spot in the focused diffraction pattern of an optical system. A star focused in a telescope forms a diffraction pattern rather than a point. The diffraction pattern looks like a central bright spot with a series of rings around it which are successively less bright. If the telescope is defocused a slight amount, the diffraction pattern is easier to see. The diffraction pattern is small, so in order to see it, you must use a high power eyepiece. Furthermore, the radius of the Airy Disk is inversely dependent on the radius of the aperture of the telescope. The larger the telescope, the smaller the Airy Disk, therefore the better the resolution. |
| Alignment Stars           | These are stars used to align the Ultima 2000's model of the sky with the actual sky. The Ultima 2000 has a list of 28 bright alignment stars. You do not have to align the telescope to only these stars as any object contained in the database of the Ultima 2000 can be used.   |
| All-Sky Pointing Accuracy | This refers to how well the telescope points at objects all over the sky. It is common for computerized telescopes to point well near their alignment stars but not quite as well away from their alignment stars.  |
| Altazimuth                | A form of telescope mounting in which the two independent rotation axes allow movement of the instrument in altitude (up/down) and azimuth (left/right). It is the simplest type of telescope mounting but it requires movement of both axes in order to track the motion of the stars. For that reason it was not a suitable mount for amateur telescopes until computerized telescopes, like the Ultima 2000, were made available.  |
| Altitude                  | The angle between the horizon and a point in the sky. Directly overhead is 90° and the horizon is 0°. Usually used in conjunction with azimuth to locate a specific point in the sky from a specific location.  |
| Aperture                  | The diameter of the objective lens.   |
| Astronerd                 | A person that all should aspire to be like.   |
| Auto guider               | A CCD chip used in place of a guiding eyepiece for long exposure astrophotography or CCD imaging. The auto guider makes fine adjustments to the telescopes tracking rate to correct for errors in the tracking gears. It can also make adjustments in declination to correct for polar alignment errors.  |
| Azimuth                   | The angle between the direction of a point with North. Usually used in conjunction with altitude to locate a specific point in the sky from a specific location. It is standard that azimuth is measured by the number of degrees a point is away from North. South would be 180°. A compass measures azimuth.  |

## *Glossary*

|                       |  |
|-----------------------|--|
| Back Focus            | Refers to how far back of the rear cell (back of the telescope) the telescope focuses. This only applies to telescopes with a variable focus like a Schmidt-Cassegrain.  |
| Backlash Compensation | This minimizes the effect of backlash (see Backlash Dead Zone) by running the motors at maximum speed through the dead zone then returning to the normal speed just as the dead zone is traversed. The Ultima 2000 does this automatically and allows you to change the compensation value.  |
| Backlash Dead Zone    | Gears in telescope have some amount of play. The dead zone refers to the time it takes for the gears to traverse the play. This is seen in the eyepiece as a period when the telescope does not move even though the motors have been activated. It is most noticeable when the direction of the motor is changed.   |
| CCD                   | Abbreviation for charge-coupled device. An electronic imaging device widely used in astronomical applications. The CCD consists of semiconducting silicon; when photons of light fall on it, free electrons are released. An array of electrodes collect the liberated electrons in the same pattern as the photons fall onto the silicon. Each electrode is known as a well or a pixel. Electric charge in each pixel is transferred through a series of gates to a place where the charge can be counted and converted into a form in which the whole image can be stored in a computer. |
| Clutch                | An adjustable mechanism that causes friction between the drive gears of the telescope and the telescope itself. The advantage to a clutch drive system is that the telescope can be moved by hand or by the motors.  |
| Collimation           | The alignment of the optical components of an optical system. In Schmidt-Cassegrains, the secondary mirror is adjusted in order to collimate the system. In Newtonian telescopes the primary mirror is adjusted.   |
| Control Buttons       | Refers to the UP, DOWN, and ENTER buttons on the hand control of the Ultima 2000. These buttons control the software.  |
| Declination (DEC)     | This is the terrestrial latitude system projected onto the sky. Used with Right Ascension, an objects location can be defined. The system of RA and DEC is referred to as the Celestial Coordinate System.   |
| Diamond Buttons       | Refers to the four directional buttons on the hand control of the Ultima 2000 that control the motors. These buttons are laid out in a diamond pattern and are diamond shaped.   |
| Diffraction           | Since light behaves like a wave when it encounters an edge, or in our case, an aperture, a focused plane wave does not form a point. It forms a pattern with a central bright disk with successively dimmer rings. Each are separated by dark rings. See Airy Disk   |
| Downstop              | A reference position for the optical encoders on the Ultima 2000. There is an encoder for each axis, Altitude and Azimuth. Each of these axes has a downstop. The Altitude downstop is a black pin located on the inside of the fork arm which contacts a black pin located on the front cell of the tube. The Azimuth downstop position is referenced by a sticker located on the drive base and a sticker located on the polar housing. Line up the two stickers for the downstop position.  |

## Glossary

|                      |   |
|----------------------|---|
| Point Source         | An object which cannot be resolved into an image because it is too far away or too small is considered a point source. A planet is far away but it can be resolved as a disk. Most stars cannot be resolved as disks, they are too far away. The image of a point source is a diffraction pattern formed by the aperture interacting with the plane wave (light from a distant object).           |
| Extended Object      | An object that has some measurable angle. Some examples are the Moon, Jupiter, the Andromeda Galaxy, and the Dumbbell Nebula. The significance of an extended object versus a point source in astronomy is that the extended object has a surface brightness.   |
| Field Rotation       | This is when the star images in a field of view of some device rotate about the center of the field. This occurs when you have a telescope that is tracking the sky and is not polar aligned. At the celestial equator, this effect is minimized. At the celestial poles this effect is maximized. The Ultima 2000 will exhibit field rotation when you are using it in the Alt-Az configuration. |
| Focal Ratio, f#      | The ratio of the focal length to aperture.  |
| Go To                | This is a feature that is unique to a computerized telescope. When the telescope is given the GO TO command, it slews to the current object selected in its object catalog.   |
| Hex                  | Short for hexadecimal. This is a base-16 numbering system. Rather than having 10 different integers, like the decimal system, hexadecimal has 16 different integers. They are; 0-9, A, B, C, D, E, F. A=10, B=11, ... , and F=15.   |
| Latitude             | The coordinate system on the Earth which measures angular distance from the equator. The equator is 0° and the North pole is 90°. When polar aligning a telescope, the altitude the Celestial pole is above the horizon is equal to the latitude of the observing sight.  |
| Longitude            | The coordinate system on the Earth which measures the angular distance around the planet orthogonal to its axis of rotation.  |
| Meridian             | A reference line in the sky that starts at the North celestial pole and ends at the South celestial pole and passes through the zenith. If you are facing South, the meridian starts from your Southern horizon and passes directly overhead to the North celestial pole.   |
| Messier              | Messier was a French astronomer in the late 1700's who was primarily looking for comets. Comets are hazy diffuse objects and so Messier cataloged objects that were not comets to help his search. This catalog became the Messier Catalog, M1 through M110.  |
| North Celestial Pole | The point in the Northern hemisphere around which all the stars appear to rotate. This is caused by the fact that the Earth is rotating on an axis that passes through the North and South celestial poles.   |
| Objective            | Refers to the primary mirror of a reflecting telescope or the front lens of a refracting telescope.   |
| Parallax             | The difference in apparent direction of an object as seen from two different points. Humans can distinguish distances between objects due to the parallax caused by having two eyes. Most astronomical objects are so far away that the effects of parallax are negligible.   |
| Parfocal             | Refers to a group of eyepieces that all require the same distance from the focal plane of the telescope to be in focus. This means when you focus one parfocal eyepiece all the other parfocal eyepieces, in a particular line of eyepieces, will be in focus.  |

## *Glossary*

|                      |  |
|----------------------|--|
| Polar Alignment      | Making the axis of rotation of a telescope mount parallel to the axis of rotation of the Earth.  |
| Prime Focus          | This usually refers to the position of an instrument, like a camera, on a telescope. A telescopes objective focuses on a plane known as the focal plane. Placing a camera in a position such that the film plane coincides with the focal plane is known as placing the camera at prime focus.   |
| Resolution           | The minimum detectable angle an optical system can detect. Because of diffraction, there is a limit to the minimum angle, resolution. The larger the aperture, the better the resolution as shown by the equation,   |
|                      | $\theta = 1.22 \bullet \frac{\lambda}{D}$  |
|                      | where $\theta$ is the resolution of the system, in radians, $\lambda$ is the wavelength of light, and $D$ is the diameter of the objective lens.   |
| Right-Ascension (RA) | This is like the terrestrial longitude system extended onto the sky. The difference is this coordinate system is fixed to the sky rather than being fixed to the Earth. Therefore, the RA of a point in the sky does not change. Used in conjunction with Declination, an objects position can be defined.   |
| Sidereal Rate        | This is the angular speed at which the Earth is rotating. Telescope tracking motors drive the telescope at this rate. The rate is 15 arc seconds per second or 15 degrees per hour.  |
| Slew                 | When the telescope moves quickly across the sky, this is referred to as slewing. But, some refer to slewing as any time the telescope is moving at greater or less than sidereal rate such that an object in the eyepiece can noticeable be seen to move rapidly. For a telescope tracking at sidereal rate, an object in the eyepiece does not move at all. |
| South Celestial Pole | The point in the Southern hemisphere around which all the stars appear to rotate. This is caused by the fact that the Earth is rotating on an axis that passes through the North and South celestial poles.  |
| User Interface       | The display screen and the control buttons on the hand control that allow the telescope to be used and commanded.  |
| Warp                 | When the Ultima 2000 is aligned to the sky a warp error is given. The number is measured in degrees and it tells you how well the angle between the alignment objects matches the angle the telescope measured itself move.  |
| Wedge                | A wedge allows the telescope to be polar aligned. The wedge is attached to the tripod and the telescope is attached to the wedge. The wedge has a tilt plate that the telescope is attached to which allows the angle of the R.A. axis of the telescope to be adjusted to match the angle of the Earth's axis of rotation.                                   |
| Zenith               | The point directly over head or 90° altitude.  |

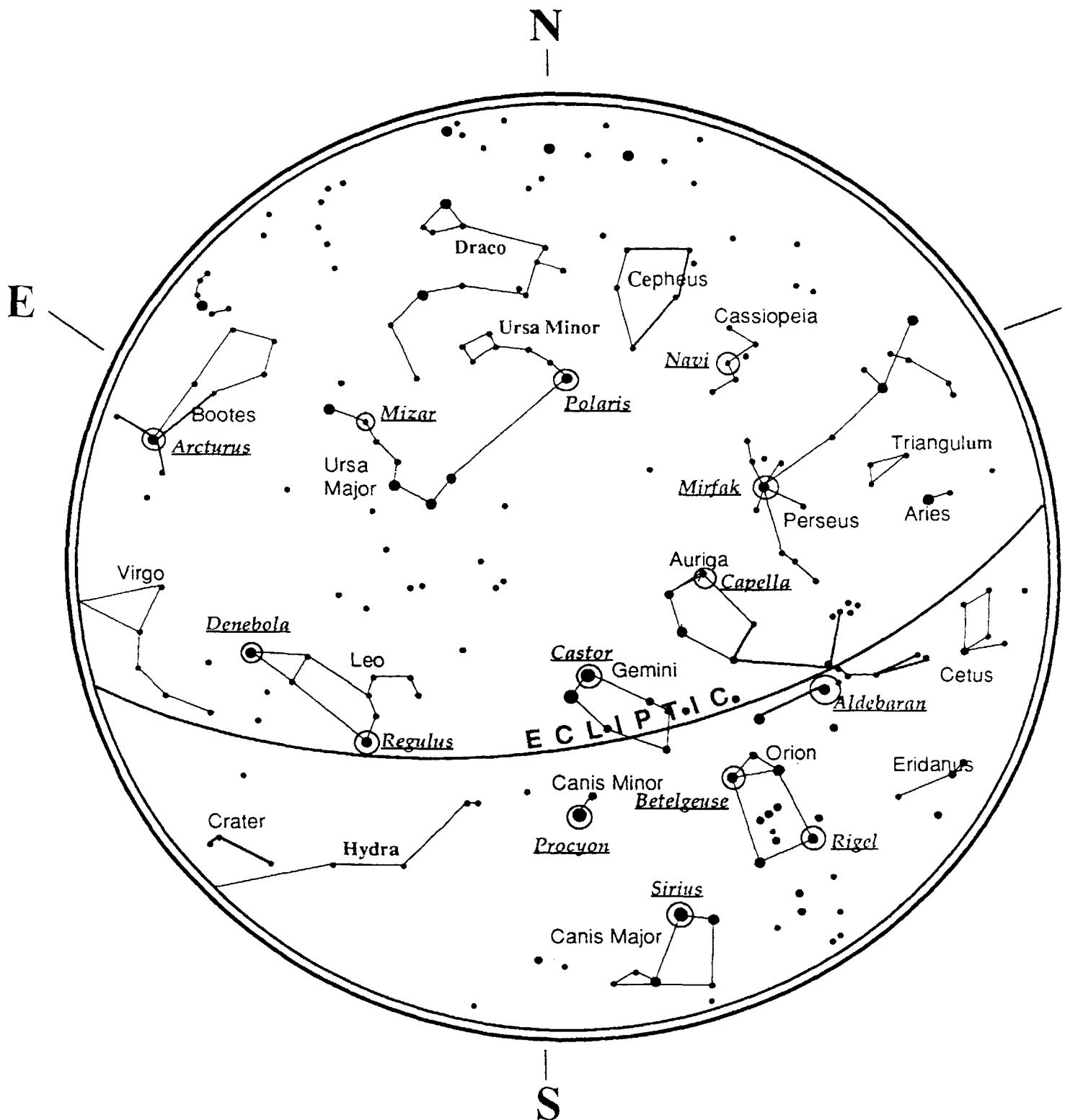
The sky is dynamic and appears to change from month-to-month, night-to-night, and even hour-to-hour. This is caused by the Earth moving around the Sun and the Earth rotating on its axis. On the following pages are sky maps for each month of the year. The first, although showing January, can be used at other times throughout the year and night. Below each map is the time the particular map can be used. You will notice that on the January map it says,

|                     |          |
|---------------------|----------|
| Early December..... | 10:00 PM |
| Late December.....  | 9:00 PM  |
| Early January.....  | 8:00 PM  |
| Late January.....   | Dusk     |

This means that the sky that the January map shows, is 'up' in early December at 10:00 PM and in early January at 8:00 PM.

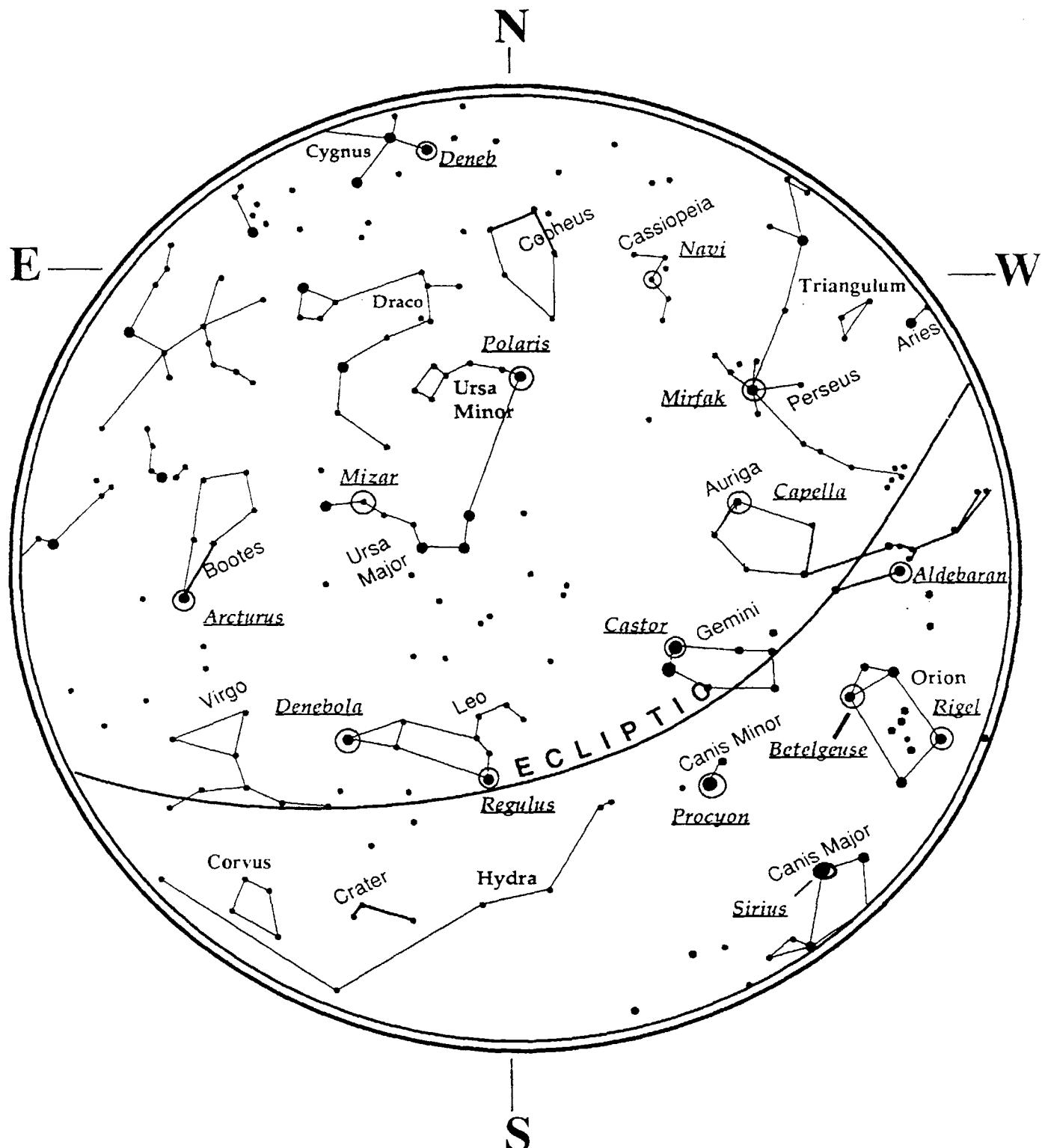
The sky maps main purpose is to provide an avenue for you to easily locate two alignment stars. All the alignment stars are printed in italic, bold, and underlined. Stars are either circled, pointed to, or have the star name next to them. Because of its proximity to the celestial pole, Polaris should NOT be used as an alignment star for equatorial mounts. If you are using the telescope in the altazimuth configuration, don't align to an object that is at the zenith (straight above).

# January Sky



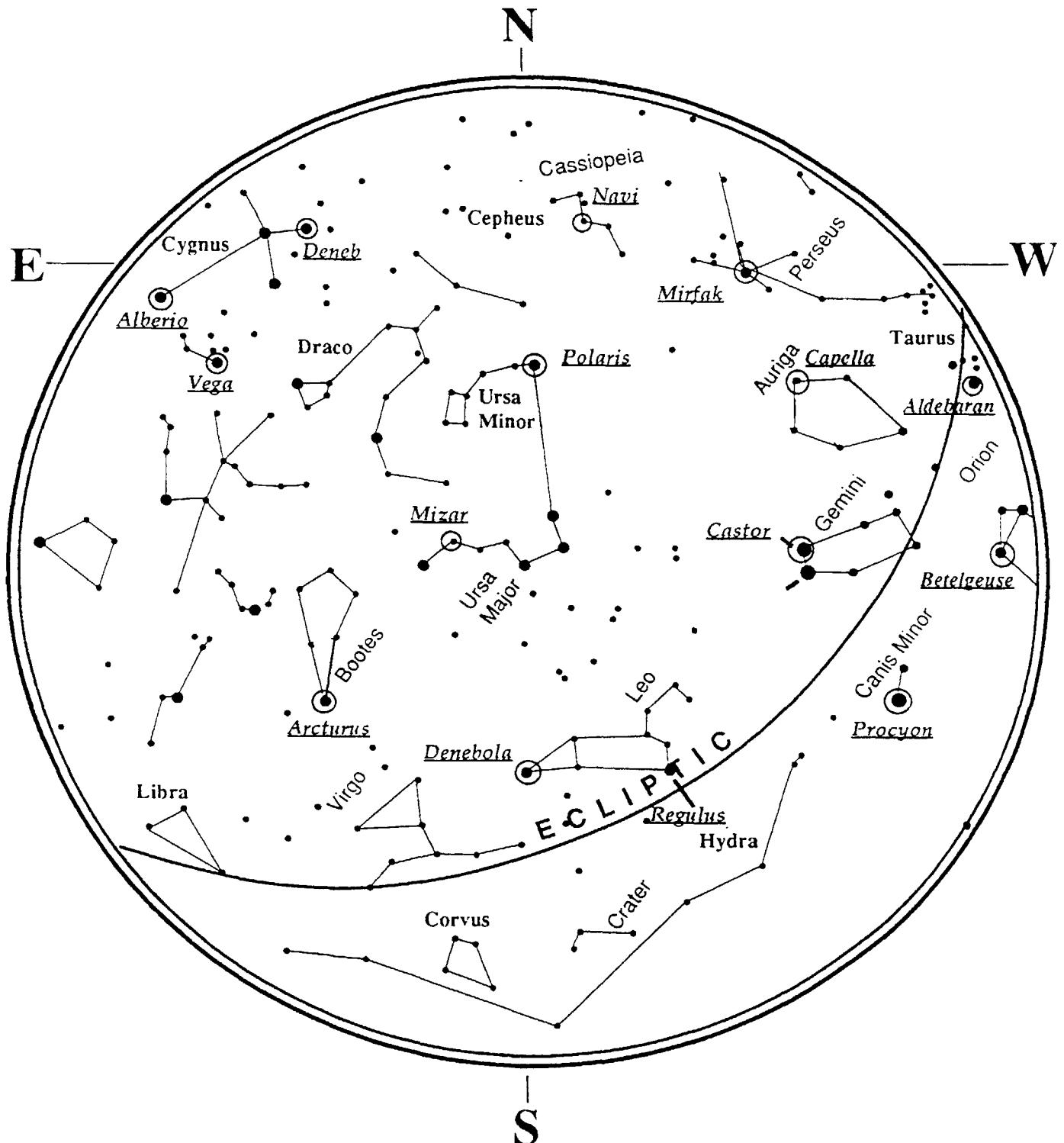
|                      |          |
|----------------------|----------|
| Early December ..... | 10:00 PM |
| Late December .....  | 9:00 PM  |
| Early January .....  | 8:00 PM  |
| Late January .....   | Dusk     |

# February Sky



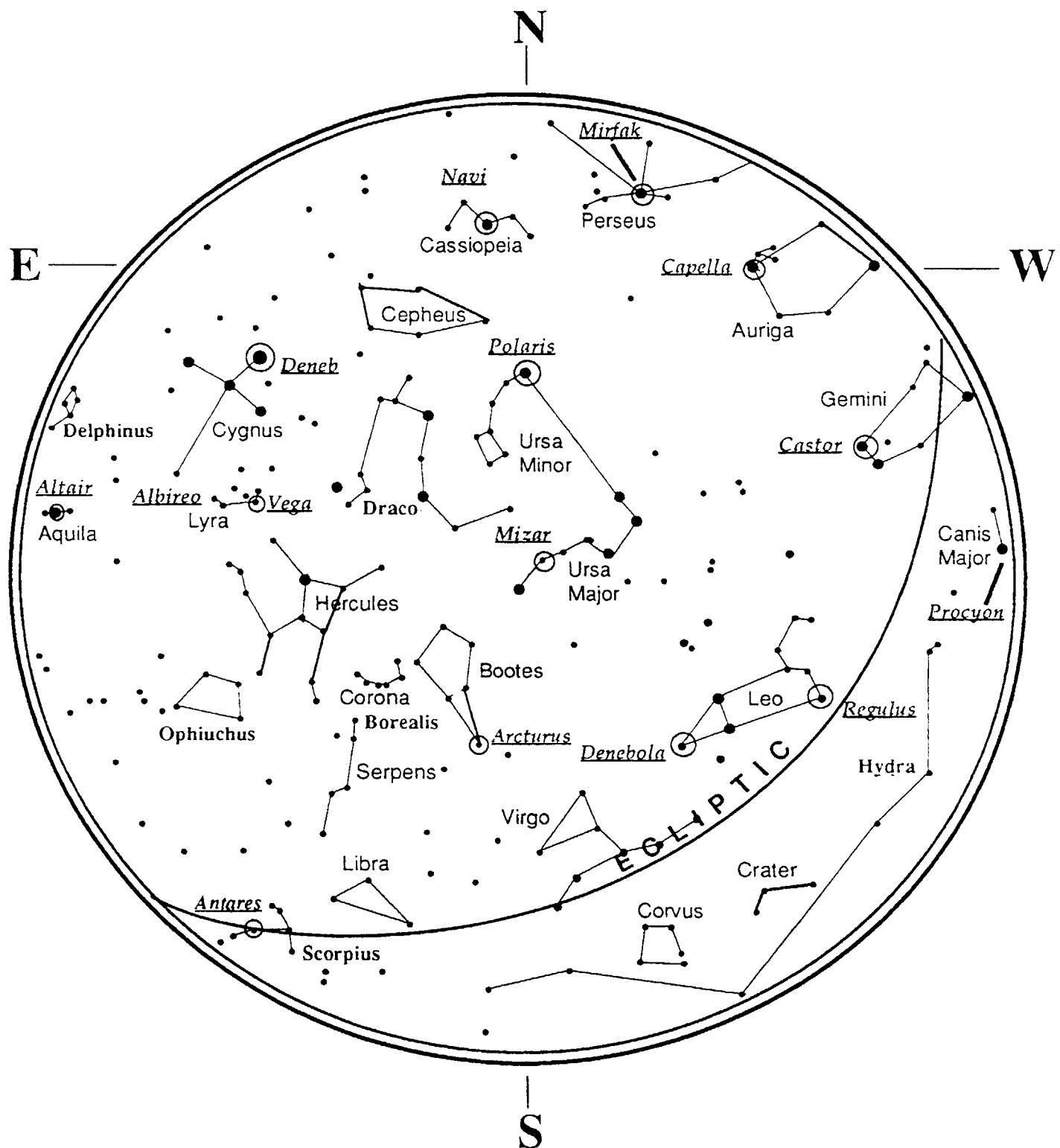
|                      |          |
|----------------------|----------|
| Early January .....  | 10:00 PM |
| Late January .....   | 9:00 PM  |
| Early February ..... | 8:00 PM  |
| Late February.....   | Dusk     |

# March Sky



|                      |          |
|----------------------|----------|
| Early February ..... | 11:00 PM |
| Late February .....  | 10:00 PM |
| Early March .....    | 9:00 PM  |
| Late March .....     | Dusk     |

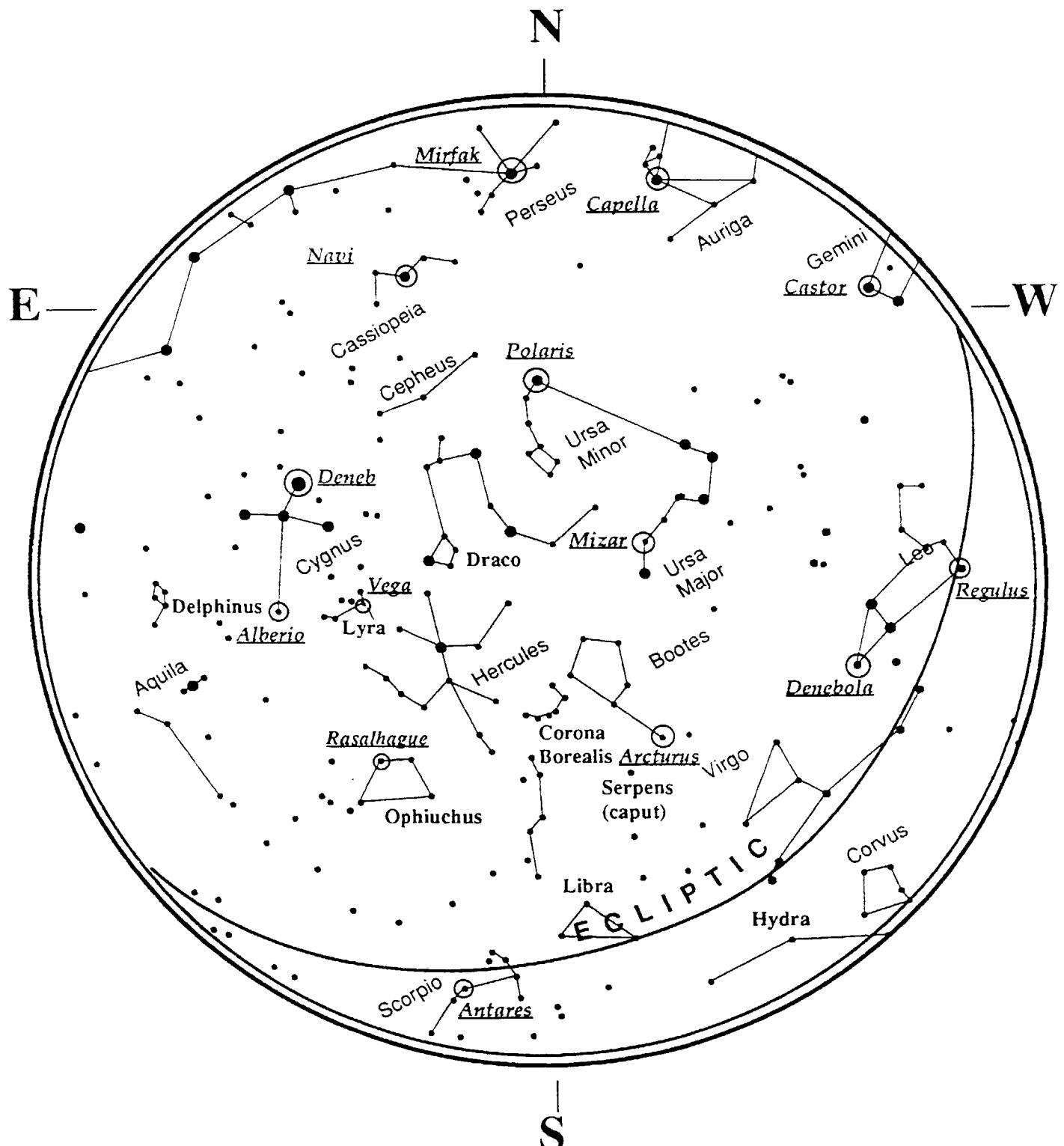
# April Sky



|                   |            |
|-------------------|------------|
| Early March ..... | 11:00 PM   |
| Late March .....  | 10:00 PM   |
| Early April ..... | * 10:00 PM |
| Late April .....  | Dusk       |

\* Daylight Savings Time

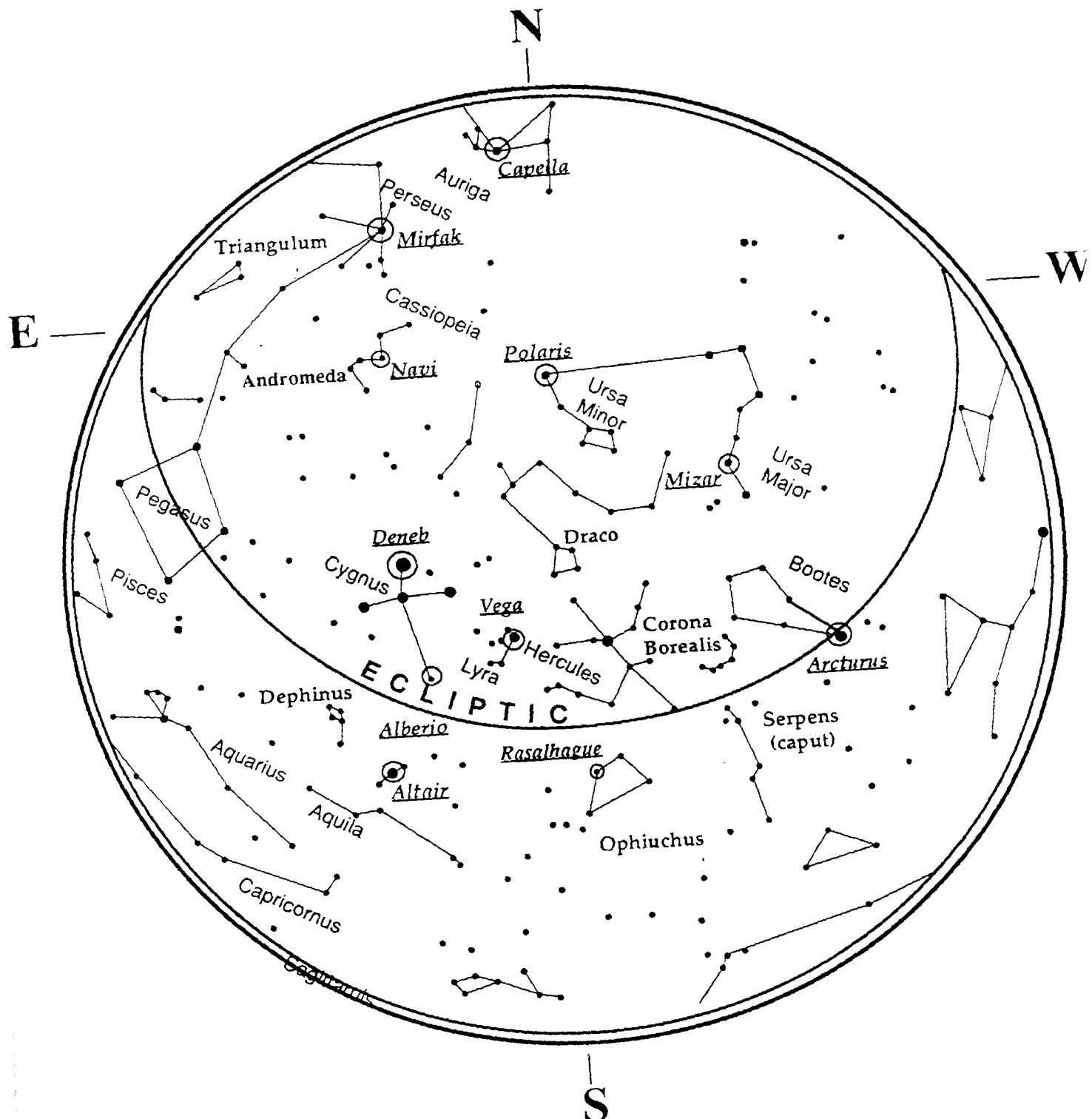
# May Sky



|                  |   |          |
|------------------|---|----------|
| Early April..... | * | 1:00 AM  |
| Late April ..... | * | Midnight |
| Early May .....  | * | 11:00 PM |
| Late May .....   |   | Dusk     |

\* Daylight Savings Time

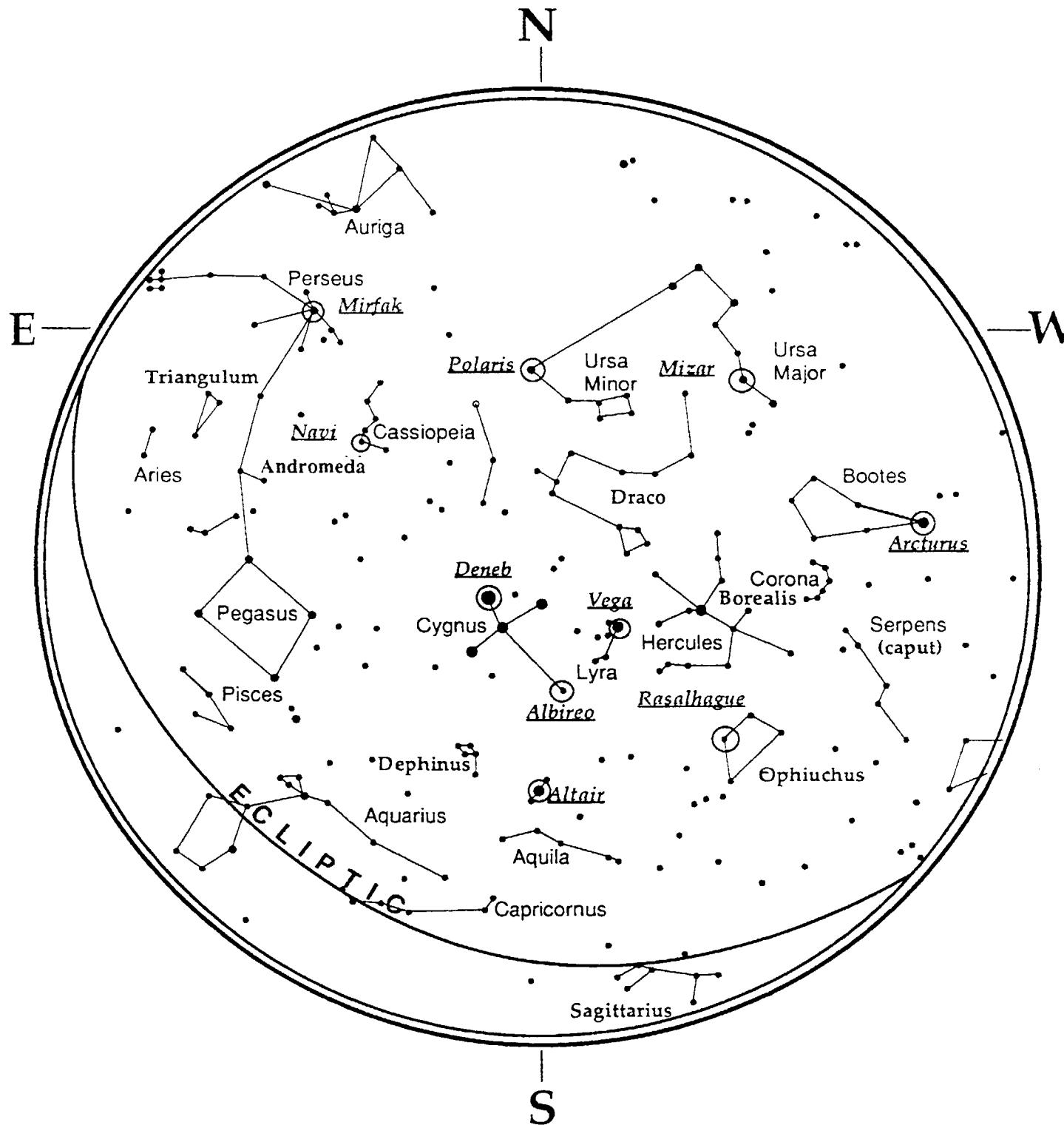
# June Sky



|                  |            |
|------------------|------------|
| Early May .....  | * 1:00 PM  |
| Late May .....   | * Midnight |
| Early June ..... | * 11:00 PM |
| Late June .....  | Dusk       |

\* Daylight Savings Time

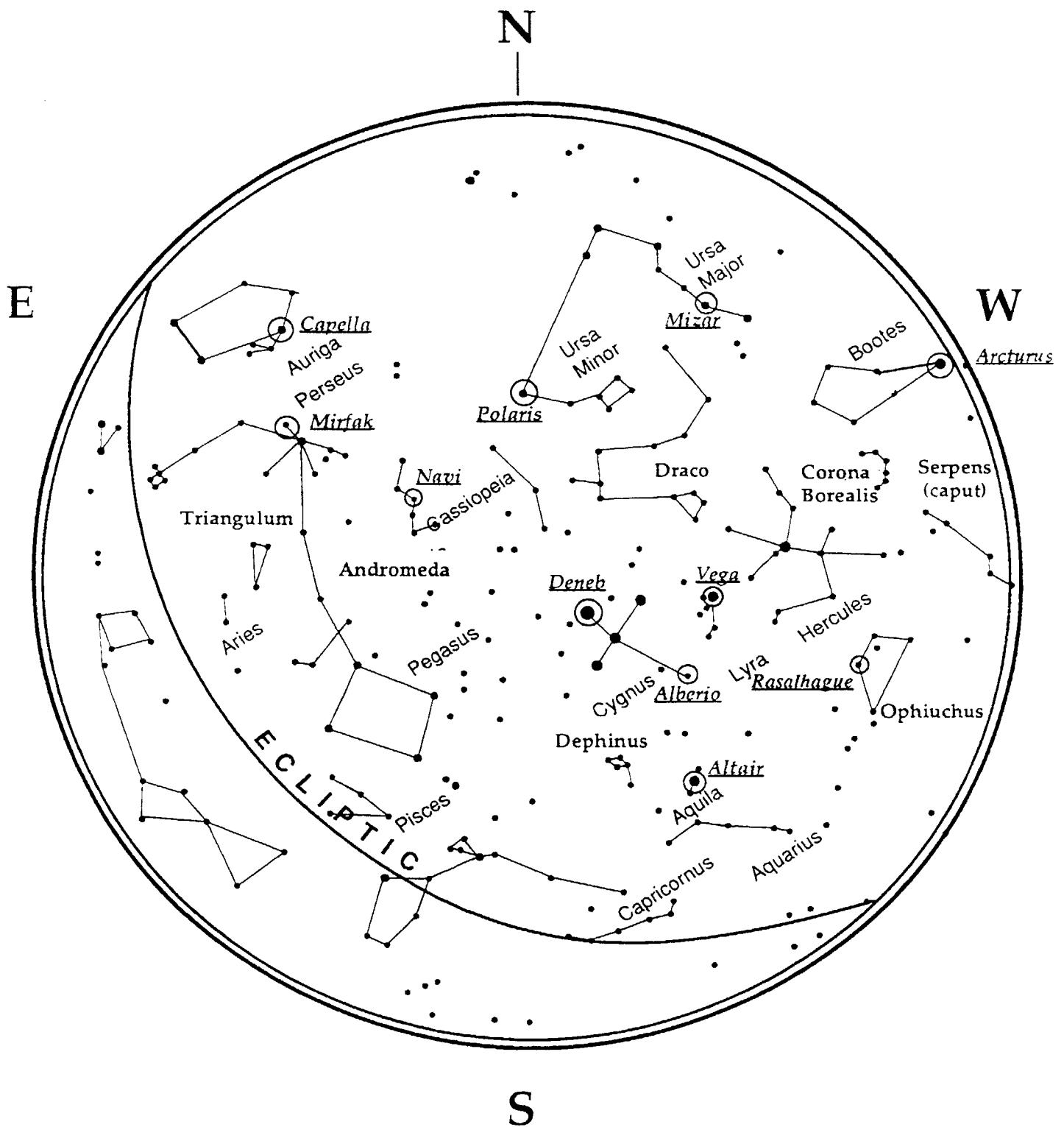
# July Sky



|                  |            |
|------------------|------------|
| Early June ..... | * 1:00 AM  |
| Late June .....  | * Midnight |
| Early July ..... | * 11:00 PM |
| Late July .....  | Dusk       |

\* Daylight Savings Time

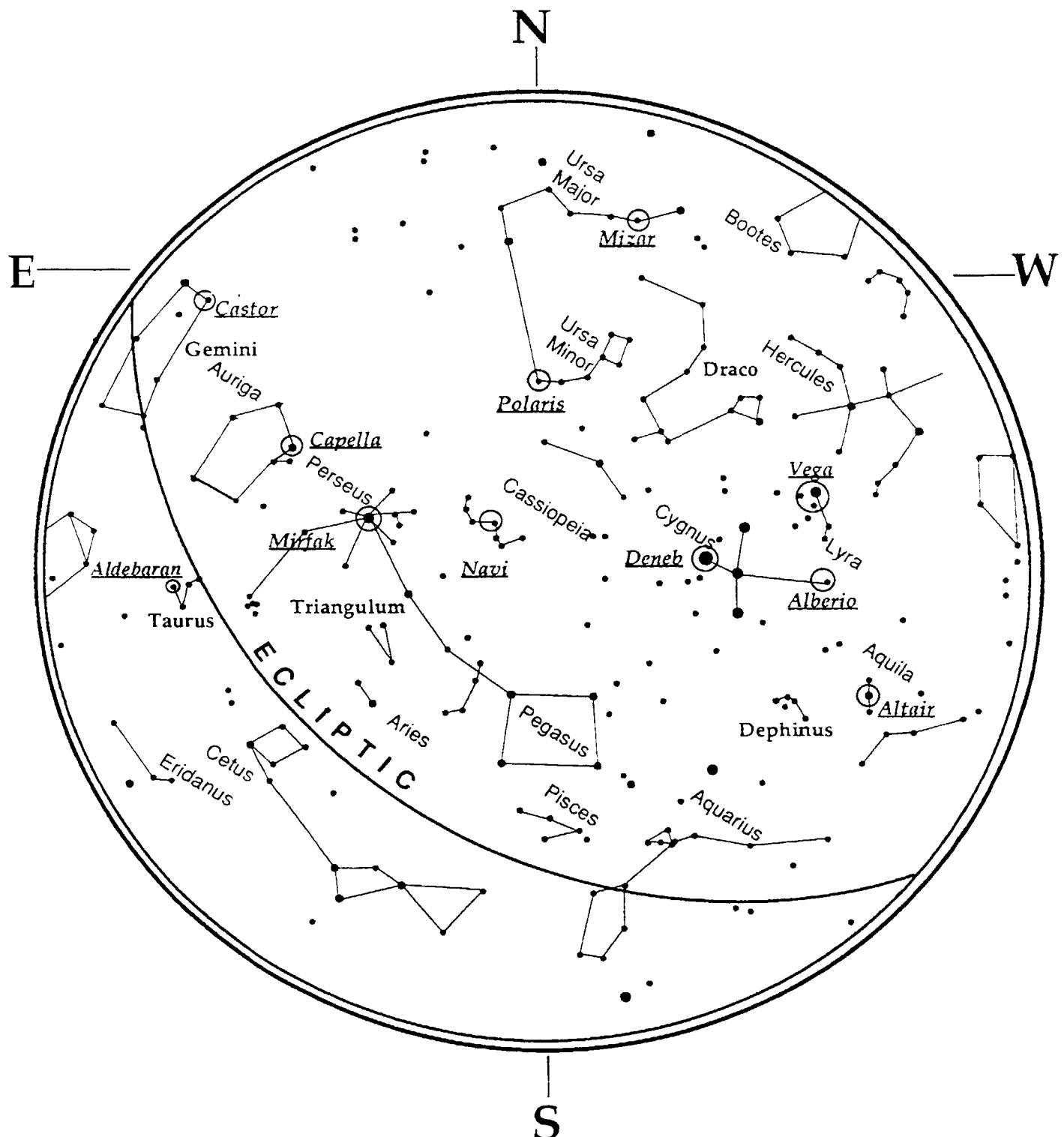
# August Sky



|                   |   |          |
|-------------------|---|----------|
| Early July .....  | * | Midnight |
| Late July .....   | * | 11:00 PM |
| Early August..... | * | 10:00 PM |
| Late August.....  |   | Dusk     |

\* Daylight Savings Time

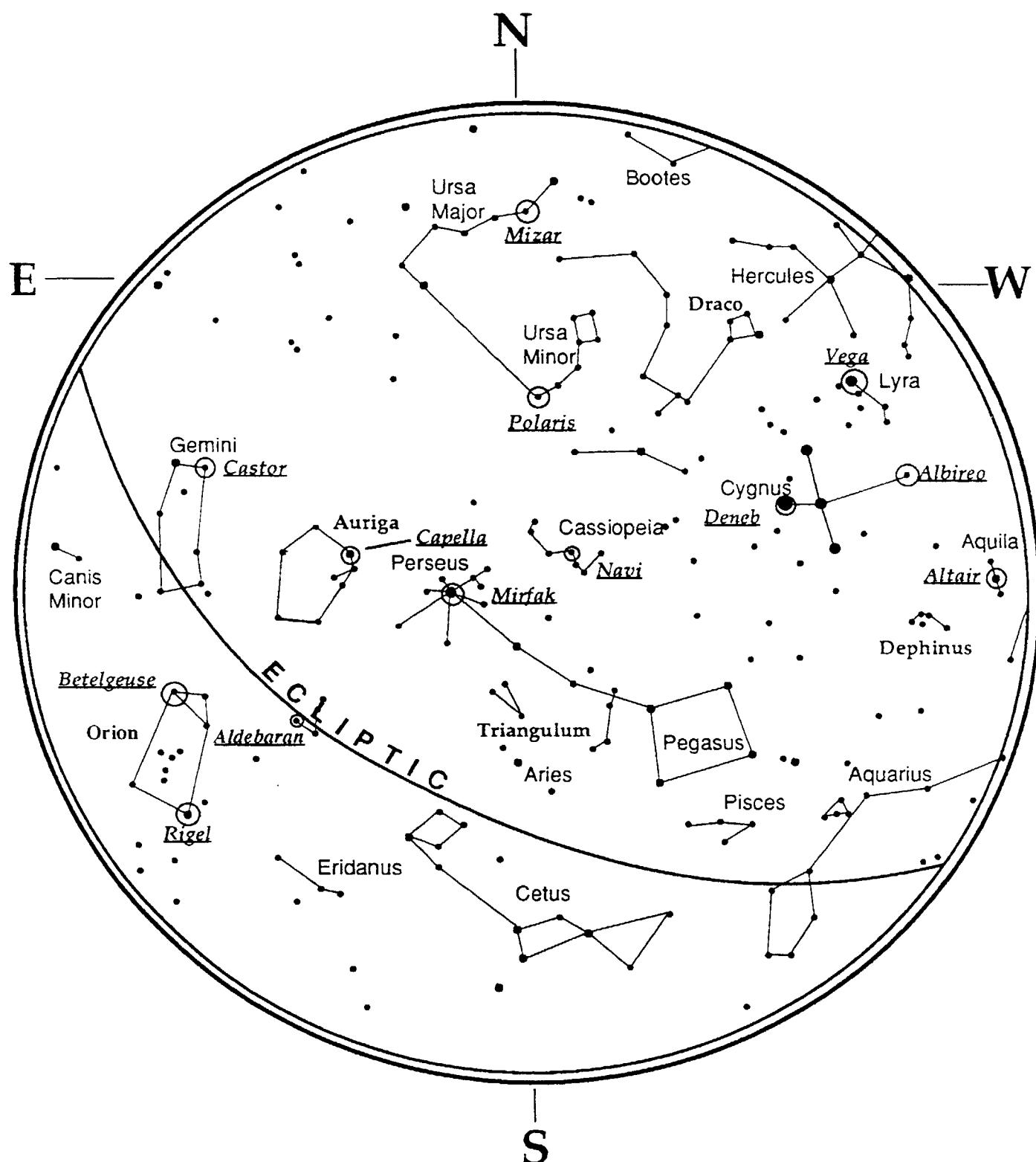
# September Sky



|                       |            |
|-----------------------|------------|
| Early August.....     | * 11:00 PM |
| Late August .....     | * 10:00 PM |
| Early September ..... | * 9:00 PM  |
| Late September .....  | Dusk       |

\* Daylight Savings Time

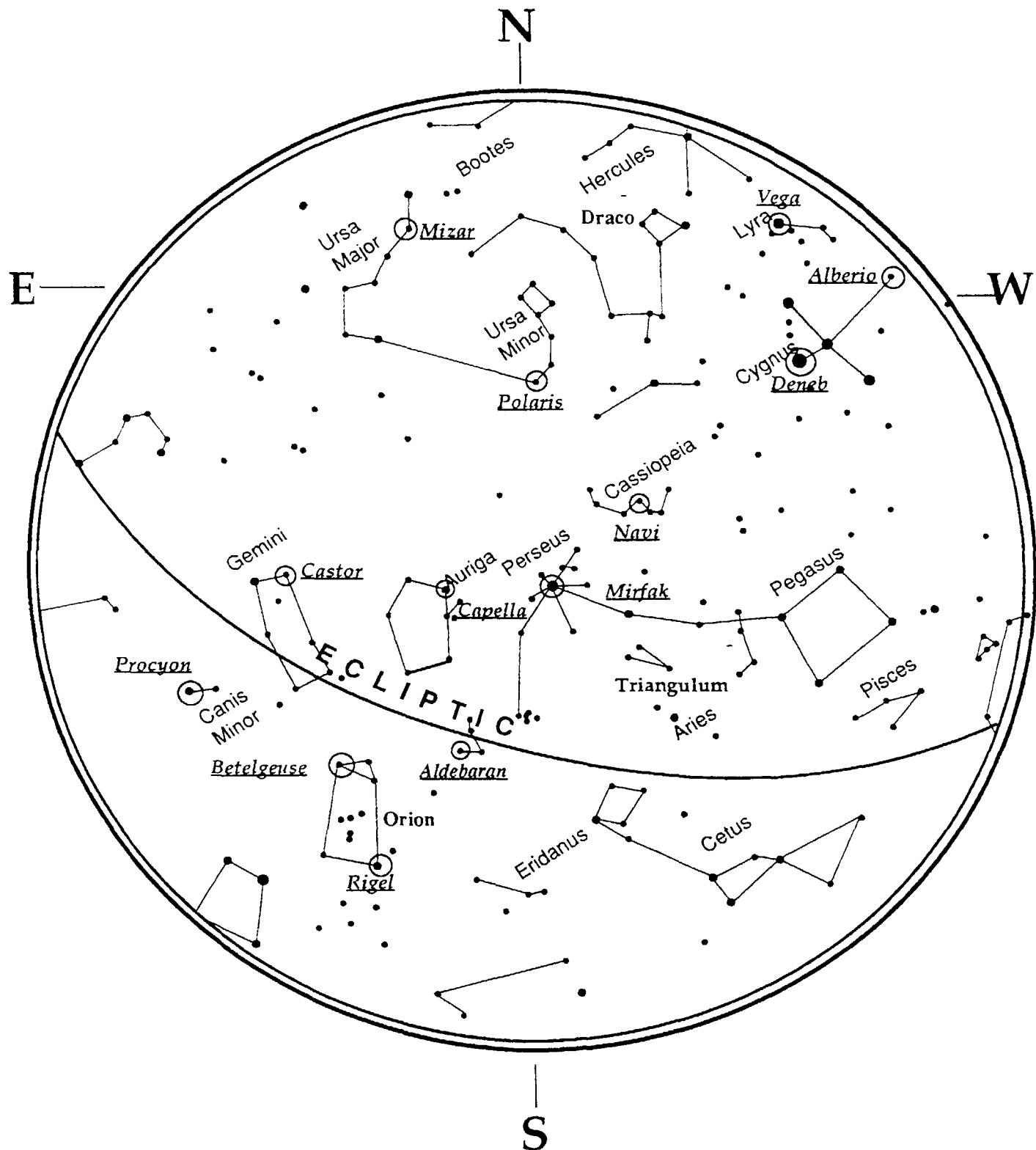
# October Sky



|                       |            |
|-----------------------|------------|
| Early September ..... | * 11:00 PM |
| Late September .....  | * 10:00 PM |
| Early October .....   | * 9:00 PM  |
| Late October .....    | Dusk       |

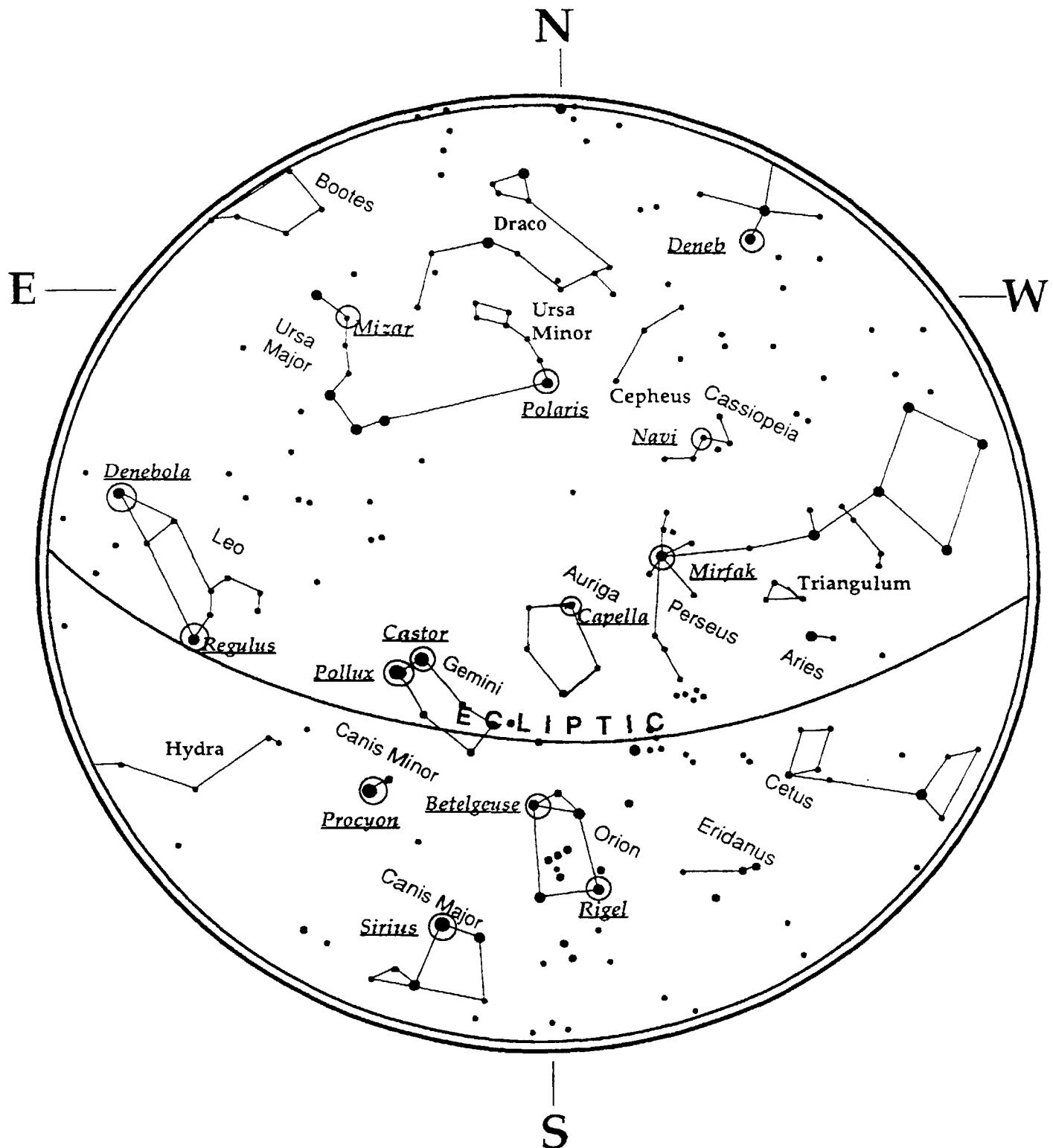
\* Daylight Savings Time

# November Sky



Early October ..... 10:00 PM  
Late October ..... 9:00 PM  
Early November ..... 8:00 PM  
Late November ..... 7:00 PM

# December Sky



|                      |          |
|----------------------|----------|
| Early November ..... | 10:00 PM |
| Late November .....  | 9:00 PM  |
| Early December ..... | 8:00 PM  |
| Late December .....  | 7:00 PM  |

## CELESTRON ONE YEAR WARRANTY

- A. Celestron International (CI) warrants this telescope to be free from defects in materials and workmanship for one year. CI will repair or replace such product or part thereof which, upon inspection by CI, is found to be defective in materials or workmanship. As a condition to the obligation of CI to repair or replace such product, the product must be returned to CI together with proof-of-purchase satisfactory to CI.
- B. The Proper Return Authorization Number must be obtained from CI in advance of return. Call Celestron at (310) 328-9560 to receive the number to be displayed on the outside of your shipping container.

All returns must be accompanied by a written statement setting forth the name, address, and daytime telephone number of the owner, together with a brief description of any claimed defects. Parts or product for which replacement is made shall become the property of CI.

**The customer shall be responsible for all costs of transportation and insurance, both to and from the factory of CI, and shall be required to prepay such costs.**

CI shall use reasonable efforts to repair or replace any telescope covered by this warranty within thirty days of receipt. In the event repair or replacement shall require more than thirty days, CI shall notify the customer accordingly. CI reserves the right to replace any product which has been discontinued from its product line with a new product of comparable value and function.

**This warranty shall be void and of no force of effect in the event a covered product has been modified in design or function, or subjected to abuse, misuse, mishandling or unauthorized repair. Further, product malfunction or deterioration due to normal wear is not covered by this warranty.**

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This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

CI reserves the right to modify or discontinue, without prior notice to you, any model or style telescope.

If warranty problems arise, or if you need assistance in using your telescope contact:

Celestron International  
Customer Service Department  
2835 Columbia Street  
Torrance, CA 90503  
Tel. (310) 328-9560  
Fax. (310) 212-5835  
Monday-Friday 8AM-4PM PST

This warranty supersedes all other product warranties.

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**NOTE: This warranty is valid to U.S.A. and Canadian customers who have purchased this product from an Authorized CI Dealer in the U.S.A. or Canada. Warranty outside the U.S.A. and Canada is valid only to customers who purchased from a CI International Distributor or Authorized CI Dealer in the specific country and please contact them for any warranty service.**



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